INTRODUCTION

The Sacramento Valley is a rich mosaic of farmlands, cities and rural communities, wildlife refuges and managed wetlands and habitat for waterfowl and shorebirds, and meandering rivers and streams that support numerous fisheries and wildlife, including Chinook salmon and steelhead trout. To improve water quality and provide water supplies for all of these diverse areas and populations, several northern California public agencies have been working with landowners and conservation organizations to refine the Sacramento Valley's integrated regional water management program formally adopted under Water Code section 10541 on December 12, 2006. As part of this regional effort, the Sacramento Valley Water Quality Coalition (Coalition) organized around the 2003 "Regional Plan for Action" that brought together farmers, ranchers, wetlands managers, conservation organizations, water resources managers, resource conservation districts and local governments to protect and enhance water quality throughout the Sacramento Valley.

The Coalition is comprised of ten (10) subwatersheds that are by design nested within the Regional Board's Region 5a. As its primary function, the Coalition addresses agricultural and managed wetlands runoff throughout a predominantly rural area. This endeavor requires a long-term collaborative effort among the people who live and work within the region. Within these subwatersheds, Resource Conservation Districts, Farm Bureaus, water resources managers, Reclamation Districts, local watershed groups and other stakeholders have stepped forward to actively participate in managing these subwatersheds effectively and to advance the efforts necessary to improve water quality. For many years these groups have worked with landowners to implement local watershed enhancement projects for various purposes and are now committed to implementing this Plan. The leaders of these groups are actively working with farmers and wetlands managers to ensure that a unique approach to managing water quality is tailored to their crop conditions, land uses and the local hydrology.

To fit with the Basin Plan and the hydrologic nature of the Sacramento River Basin, the Coalition provides a systematic approach to address water quality. The Coalition coordinates the subwatersheds in a manner that enhances overall water quality throughout the region and to otherwise avoid conflict among the subwatersheds and the local participants. Additionally, a coordinated approach by subwatersheds within the Sacramento River Basin provides economic efficiencies and aids in streamlining the allocation of limited human and financial resources within the State of California, its agencies and the Coalition's partners as they collectively implement the Regional Plan.

SACRAMENTO VALLEY WATERSHED DESCRIPTION

The Sacramento River is the largest river in California, with an average annual runoff of 27 billion cubic meters. The Sacramento River watershed encompasses 27,000 square miles in the north central part of California. Of this area, approximately 1.3 million acres is in irrigated agriculture covered by the Sacramento Valley Water Quality Coalition (Coalition) under the Irrigated Lands Regulatory Program.

The Sacramento Valley supports a diverse agricultural economy, much of which depends on the availability of irrigation water. Water is collected in reservoirs at many locations within and surrounding the Sacramento Valley and is released according to allocations for agricultural, urban, and environmental needs. The reservoirs also serve as management tools, providing for flood protection as well as storage of water during dry years.

Major crops produced with the valley include rice, fruits, nuts, corn, grains, and alfalfa. Dairy products are also an important agricultural commodity.

The largest cities of the Sacramento River watershed include Chico, Red Bluff, Redding, and Sacramento.

The Sacramento River watershed includes all or parts of six landforms or physiographic provinces—the Great Valley, Modoc Plateau, the Middle Cascade Mountains, the Sierra Nevada, the Klamath Mountains and the Coast Ranges.

The average annual precipitation for the entire Sacramento River Basin is 914 millimeters (mm), most of which falls as rain or snow during November through March. Because little or no rain falls during the summer growing season, irrigation is required for successful agriculture. Precipitation amounts in northern California are variable and dependent on the location of the Pacific jet stream. The average annual rainfall at the city of Sacramento is about 460 mm.

SUBWATERSHED DESCRIPTION

Butte/Yuba/Sutter Subwatershed. The Butte-Yuba-Sutter subwatershed encompasses all of Butte and Yuba counties and most of Sutter County. The primary land uses include agriculture and grazing with significant crops including orchards (almonds, walnuts, peaches, prunes, and olives), row crops (beans and tomatoes), rice, alfalfa, tomatoes and pasture. Important drainages include the Yuba, Lower Feather, Bear and the Sacramento rivers. Major population areas include Oroville, Chico, Marysville and Yuba City.

Colusa Glenn Subwatershed. The Colusa Glenn Subwatershed encompasses all of Colusa and Glenn counties. The primary land uses is agriculture, with significant crops including rice, almonds, prunes, walnuts, wheat, pasture alfalfa/hay, corn, and row crops (tomatoes, melons, squash, beets and cucumbers). Important drainages include the Colusa Basin Drain and the Sacramento River. Major population areas include Williams, Colusa, Willows, and Orland.

El Dorado Subwatershed. The El Dorado Subwatershed is located within El Dorado County. Approximately half of the watershed is designated as National Forest, which includes timber harvest activities. Agricultural use occurs on a little more than 5,000 acres, with the majority of acreage planted in wine grapes. Apples are the second largest crop after wine grapes, followed by pears, walnuts, cherries, peaches and plums. In addition, approximately 500 acres are planted in conifer trees that are sold during the holidays. Important drainages include the South Fork American River and the North and Middle Forks of the Cosumnes River. The main population centers are Placerville and Camino.

Lake/Napa Subwatershed. Portions of Lake and Napa counties encompass this subwatershed. The major land uses include pasture, rangeland, vineyards and orchards. The primary agricultural crops include cattle, field and seed crops, wine grapes, pears, walnuts and nursery products, with minor crops such as apples, peaches, strawberries, melons, vegetables, eggs, cheese, wool and timber. There has been a recent increase in the number of registered organic growers in this area. Important drainages include Capell Creek, Pope Creek, Eticuera Creek, Upper Cache Creek and Upper Putah Creek. The main population areas include Clear Lake, Lower Lake, Kelseyville, Lakeport, Nice, Lucerne, Clearlake Oaks and Middletown.

Pit River Subwatershed. The Pit River Subwatershed is located primarily in Modoc County with additional acreage in Lassen and Shasta counties. Elevation differences in this watershed are dramatic, with the Warner Mountains at 9,800 feet and the Fall River Valley at 3,200 feet. Major land uses include grazing and timber harvest. Common crops produced in the Pit River Subwatershed include: alfalfa hay, alfalfa/orchard grass hay, timothy hay, assorted grass hay, oats, barley, wheat, potatoes, irrigated pasture, strawberries, nursery plants, wild rice, peppermint, garlic, onions, and various vegetable seeds. Important drainages include the Fall River and the North and South Forks of the Pit River. The main population centers include Burney, Fall River Mills, and Alturas.

Placer/Nevada/S.Sutter/N.Sacramento Subwatershed. The Placer/Nevada/S.Sutter/ N.Sacramento Subwatershed (PNSSNS) encompasses all or portions of four counties: Placer, Nevada, Sutter, and Sacramento. The primary land uses include agriculture, grazing and timber harvest. Placer County crops include fruit and nut crops, rice, pasture, and hay. Northern Sacramento County produces wine grapes, market milk, nursery stock, orchard crops (apples, oranges, peaches, plums, pears and walnuts), poultry, field corn, calves and cattle, silage corn, rice and processing tomatoes. Main commodities in Sutter County include prunes, rice, walnuts, peaches and milk. Primary commodities in Nevada County include timber, heifer and steers, winegrapes, irrigated pasture, and pasture and rangeland. Important drainages are the American, Sacramento and Bear Rivers. The main population areas include Sacramento, Roseville, Lincoln, Auburn, and Grass Valley.

Sacramento/Amador Subwatershed. The Sacramento-Amador Subwatershed encompasses portions of two counties, Sacramento (south of the American River) and Amador (north of the Mokelumne watershed). Crops produced include: wine grapes, citrus, mixed pasture, corn (field and silage), grain and hay, alfalfa, walnuts, rice, tomatoes, nursery stock, calves and carrel, poultry and safflower. Important drainages include the Sacramento River and the Cosumnes River. The Cosumnes River contains three segments: the Lower, Middle and Upper Forks. The main tributaries to the Cosumnes River are Deer Creek and Laguna Creek. The main population center is Elk Grove.

Shasta/Tehama Subwatershed. The Shasta/Tehama subwatershed includes Tehama County and Shasta County below Shasta dam. The primary land use is agriculture, which includes pasture, orchards, field and forage crops, winegrapes, alfalfa/grass and small grains, walnuts, prunes/plums, almonds, olives, corn, dry beans, wheat and rice. According to the 2007 county farm reports, about 131,518 acres are irrigated within these two counties. Important drainages are Thomes Creek, Elder Creek, Red Bank Creek, and Cow Creek. Main population areas include Corning, Red Bluff and Redding.

Solano/Yolo Subwatershed. This subwatershed encompasses portions of Solano County and all of Yolo County. Also include is a small portion of Colusa County. Variable topography includes steep, mountainous uplands, low well-rounded hills, and level soils suitable for irrigated crops or dry farming. The primary land uses are agriculture and grazing. The irrigated crops include field crops such as alfalfa hay, wheat, field corn, and sorghum/milo, winegrapes, rice, walnuts, prunes, almonds, vegetables (predominately processing tomatoes), seeds (dry beans and sunflowers), and nursery stock. Important drainages include Cottonwood and Willow Sloughs, and Cache and Putah Creeks. Main population areas include Davis and Woodland.

Upper Feather River Subwatershed. The Upper Feather River Subwatershed includes all or a portion of Plumas, Sierra and Lassen counties. The Upper Feather River Subwatershed includes 3,222 square miles of land that drains west from the northern Sierra Nevada into the Sacramento River. The Feather River is unique in that the two branches, the North and Middle Forks, originate east of the Sierra Range in the Diamond Mountains and as these two forks flow west, they breach the crest of the Sierra Nevada Range on their way to Lake Oroville. Elevation ranges from 2,250 to over 10,000 feet, and annual precipitation varies broadly from more than 70 inches on the wet western slopes to less that 12 inches on the arid east side. The USDA Forest Service manages over 80% of the watershed, while alluvial valleys are predominantly privately owned and used for livestock grazing and hay production. The significant crops consist primarily of alfalfa, hay, and pasture that may be irrigated, non-irrigated, or range for livestock production. Logging is also a major activity within the subwatershed. Largest urban areas include Quincy, Portola, Loyalton, Greenville, Graeagle, Chester and Sierraville.

COALITION COUNTY DESCRIPTIONS

Below is a description of the geography climate, hydrology-drainage patterns, land use/crop types, and soils in 20 counties located within the Coalition area.

AMADOR COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Amador County is one of the smaller mountain counties on the western slope of the Sierra Nevada Range in central California. It is narrow, long and somewhat irregular in shape. To the west the county merges with the Great Valley of California, and to the east it extends to the crest of the Sierras. The south fork of the Cosumnes River forms the northern boundary of the county, and the Mokelumne River is the border on the south. The county is roughly 54 miles long. Its elevation ranges from 250 feet in the low foothills to more than 9,000 feet in mountainous peaks near the eastern boundary.

There are three main physiographic sections in the Amador County: (1) Mountainous uplands; (2) Middle and lower foothills; and (3) Arroyo Seco pediment, alluvial terraces, and flood plains.

The mountainous uplands are deeply entrenched by streams that flow southwestward. On the north and south, they are bordered by deeply gouged river canyons. Their elevation ranges from 1,200 to more than 5,000 feet. The native vegetation is chiefly forests of conifers and hardwoods. The mountainous uplands occupy about 40% of the area.

The middle and lower foothills consist of rolling to steep hills with conspicuous peaks and ridges, of mesa-like plateaus with steep to sloping side hills and of gently undulating flats and valleys. Grass, grass-oak, brush, and scattered conifers make up the vegetation. The middle and lower foothills make up about 40% of the area.

The Arroyo Seco pediment, alluvial terraces, and flood plains of Amador County consist of dissected terraces and escarpments, of rolling rounded hills, of tabletop buttes, and of nearly level valley bottoms and stream terraces. Most of the alluvium is on terraces in the Jackson and Ione Valleys. Elevation in this region ranges from 250 feet to 500 feet.

Climate. The Amador area generally has warm, dry summers and mild winters. Occasionally, however, thundershowers occur in summers at the higher elevations. Also, temperatures of more than 100^{o} Fahrenheit (F) occur nearly every year, and sometimes temperatures drop well below freezing in winter. Most of the precipitation comes during the 6 months of winter, and the seasonal total ranges from less than 20 inches at low elevations to more than 40 inches at higher elevations. In the lower foothills there is little snowfall, but at higher elevations the amount of snowfall is fairly large.

In general, temperatures decrease with increase in altitude, but in low, sheltered areas cold air tends to accumulate. As a result, in these low places the average temperature is somewhat cooler than on the adjoining slopes. The amount of precipitation generally increases with increases in elevation. Most of the precipitation in winter falls when a southwest wind is blowing, and much of it falls on the windward side of the hills. When precipitation is heavy, however, the upper parts of the leeward side of the slopes sometimes receive large amounts of moisture carried over from the windward side. Because the main drainageways run in a southwesterly direction, west and southwest winds can sweep up the slopes of the area with little resistance. Locally, however, many places are sheltered from winds by configurations of the terrain.

The average annual temperature in Amador County ranges from nearly 65^{o} F at the lower elevations to about 56^{o} F at upper elevations. Minimum temperatures average 44^{o} F and are most affected by local variations in the terrain. The average maximum temperature is 75^{o} F, with summer temperatures reaching 100^{o} F.

Hydrology – Drainage Patterns. Amador County's Subwatershed is bordered on the north by the Cosumnes River and on the south by the Mokelumne River.

The natural drainage in the Amador County watershed generally flows east to west. The northern part of the county flows northwest into the Cosumnes River, which then flows into the Mokelumne River. The middle and lower foothills of Amador County flow in a northwest direction into Dry Creek, which then flows into the Cosumnes River.

Most of Amador County's secondary streams are seasonal; Dry Creek will dry up during the summer months. Jackson Valley Irrigation District allows very controlled flows down Jackson Creek for irrigation purposes. Jackson Creek flows into Dry Creek about two miles from the western end of Amador County. At that point, the water is pumped out of Dry Creek and used for irrigation purposes. There is no water leaving Amador County through Dry Creek.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Amador County include winegrapes, cattle and calves, timber, pasture and rangeland, and livestock. There are four major areas of irrigated agriculture in Amador County. Other land is devoted to grazing and timber production.

1. Shenandoah Valley - The largest and best known farming area in Amador County. This is an area of gently rolling hills set in a valley above Plymouth. Soils are relatively deep and support grapes, walnuts, flowers, and olives. Most of the local wineries are located in this area. Most of the land is in the Williamson Act and is zoned AG-40. Fields are primarily drip irrigated with well water, although a small percentage is dry farmed.

2. Jackson Valley - Jackson Valley is located in the southwestern portion of the county and follows Jackson Creek as it leaves Lake Amador. This area has the only irrigation district in the county with water delivered to some parcels under pressure. Crops grown in the area include grapes, walnuts, alfalfa, and field crops. Most of this land is zoned AG-40 and is in the Williamson Act.

3. Ione Valley - Ione Valley is located to the south and west of the city of Ione and generally follows Dry Creek and Sutter Creek. Crops grown in the area include fruits, melons, berries, hay, and pumpkins. Water is provided from creeks, effluent or wells. Most of the area outside the city limit is zoned AG-40 and in the Williamson Act.

4. Ridge Road -Located above Sutter Creek between Highway 49 and New York Ranch Road, this area has been in agriculture since the gold rush. This area has moderately deep soils that support grapes. This area receives water from the Amador Canal, which is also a source of drinking water for most of the cities in the county. The area is zoned AG-40 and AT-5.

Soils. There are three main physiographic sections in the Amador County: (1) Mountainous uplands; (2) Middle and lower foothills; and (3) Arroyo Seco pediment, alluvial terraces, and flood plains. Each physiographic section has one or more soil associations and has been grouped principally on the basis of soil differences that are related to the parent rock.

1) Soils of the Mountainous Uplands:

a.) Mariposa-Josephine-Sites association: Shallow to deep soils in material from metasedimentary rocks. The soils in this association formed in material from uplifted, bedded, metamorphosed sediments, mainly of slate and schist but partly of limestone with fairly large inclusions of intrusive igneous rocks. In some places the ridges are capped with thin deposits of gravelly alluvium.

b.) Musick-Holland association: Deep and moderately deep soils in material from granitic rocks. The Musick and Holland soils are commonly very rocky, micaceous, porous, and very deep. The Musick soils are brown or reddish-brown sandy loams or loams. Their subsoil is red or yellowish-red clay loam or clay. The Holland soils are light brownish-gray to grayishbrown coarse sandy loam, and their subsoil is light yellowish-brown to brown sandy clay loam.

c.) Aiken-Cohasset association: Very deep, deep, and moderately deep, cobbly soils in material from volcanic conglomerate. The Aiken and Cohasset soils are cobbly, moderately deep to very deep, very friable, and acid. The Aiken are deep to very deep, dark-brown or reddish-brown loamy soils. Their subsoil is yellowish-red to red clay. The Cohasset soils are moderately deep to deep. They are similar to the Aiken soils in appearance but have less clay in the subsoil.

2) Soils of the Middle and lower foothills:

a.) Auburn-Exchequer association: Very shallow to moderately deep, rocky or gravelly soils in material from matabasic rocks and metasedimentary slate and schist. The Auburn and Argonaut soils in this association are very rocky or gravelly loams and silt loams. These soils have a brown, strong-brown, or yellowish-red surface soil and a yellowish-red subsoil. Depth to bedrock ranges from 10 to 30 inches. The subsoil of the Auburn soils is heavy loam, silt loam, or light clay loam, and has only a slight increase in clay content in comparison to its surface soil. Argonaut soils have a subsoil of yellowish-red clay that is sticky and very plastic. Exchequer soils are somewhat excessively drained, very rocky, very shallow soils that have a cover of brush. These soils are dark brown or brown and range in depth from 6 to 18 inches.

b.) Supan-Iron Mountain association: Very deep to shallow, cobbly or stony loams in material from volcanic conglomerate. Supan soils are moderately deep or very deep and have a subsoil of reddish-brown to yellowish-red clay loam. Iron Mountain soils are shallow, very stony, dark grayish-brown or dark-brown loams, and they show little change in the profile with increasing depth. They are in the same general area as some areas of Rock land and are only a little better in quality.

c.) Sierra-Ahwahnee association: Deep and moderately deep, gritty sandy loams or loams in material from granitic rocks. The Sierra soils have a surface layer of brown or yellowish-red sandy loam or loam, and their subsoil is yellowish-red to red heavy loam or clay loam. They range from 20 to more than 60 inches in depth. Ahwahnee soils are moderately deep, brown loams or fine sandy loams that have slightly finer textured, brown or light reddishbrown subsoil. The Snelling and Shenandoah soils are moderately well drained to somewhat poorly drained and are in concave swales and drainageways. They are brown, pale-brown or brownish-gray soils.

3) Soils of the Arroyo Seco pediment, alluvial terraces, and flood plains:

a.) Pentz-Pardee association: Very shallow to moderately deep soils in material from rhyolitic tuff, gravelly alluvium, marine clay, sandstone, and volcanic conglomerate. Soils are reddish-brown or yellowish-red gravelly loams. Their subsoil is red or dark-red clay or clay loam that is very strongly acid to extremely acid. Red Bluff soils formed in gravelly alluvium that mantled or interbedded areas of sandstone and clay marine sediments. They are grayishbrown to light yellowish-brown sandy loams or loamy coarse sands and are medium acid to strongly acid. Their subsoil is pale-brown, reddish-brown, or yellowish-brown sandy clay, clay, or silty clay that is very firm and is strongly acid to extremely acid. Generally, the Mokelumne soils are on concave slopes and in depressions in the lower parts of foothills.

b.) Honcut-Snelling-Ryer association: Very deep and deep, medium-textured soils in alluvium; on stream terraces and flood planes. The principal soils in this association are sandy loams, fine sandy loams, and silty clay loams. A small acreage of the Honcut soils, however, consists of silt loams or clay loams. Most of the soils are stratified, generally with finer-textured material, but in places with sand and gravel. Except for the Ryer soils, which have a surface layer that is medium acid and a subsoil that is medium acid to neutral, these soils are slightly acid to neutral in the surface soil and slightly acid, neutral, or mildly alkaline in the subsoil. Generally, fertility is moderate to high, but in the Ryer soils it is moderate to low. In some places adjacent to creeks, the soils are subject to flooding.

BUTTE COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Butte County consists of 1,676 square miles, about 66 of which are incorporated within four cities (Biggs, Chico, Gridley, and Oroville) and the Town of Paradise.

The remaining unincorporated lands under County jurisdiction - 1,610 square miles - encompass a wide variety of topography, climate, vegetation and types of land use. These can be divided into three zones: the relatively flat valley in the west, the rolling foothills and volcanic buttes in the center, and the high forested mountains and deep river canyons in the east.

Climate. Precipitation for Butte County averages about 29 inches per year, but this figure masks tremendous variation across the County. The valley rarely sees snow, the foothills an occasional dusting, and the mountains enough to temporarily shut down travel. In the valley and foothills, expect temperatures between 95° and 105° F for much of the summer, when many seasonal creeks and springs run dry.

Hydrology-Drainage Patterns. Butte County is watered by the Feather River and the Sacramento River. Butte Creek and Big Chico Creek are additional perennial streams, both tributary to the Sacramento. It is the site of Feather Falls, the sixth largest waterfall in the United States.

The county is drained by the Feather River and Butte Creek. Part of the county's western border is formed by the Sacramento River. The county lies along the western slope of the Sierra Nevada, the steep slopes making it prime territory for the siting of hydroelectric power plants. About a half dozen of these plants are located in the county.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Butte County include rice, almonds, walnuts, dried plums, and nursery stock.

Agriculture dominates land use in the valley, while logging and public lands are more common in the coniferous forests of the mountainous east. Agriculture for Butte County represents the largest land use in terms of area. It has been the principal economic base and accounts for 20% of the County's workforce. While the County has taken leadership to ensure agriculture's future, there are increasing pressures on prime agricultural areas for conversion to incompatible uses. Land divisions are gradually reducing the future security of those who want to continue to commercially farm.

According to the County Agricultural Commission's Report, **t**he top five crops of value in 2006 includes rice, almonds, walnuts, dried plums and nursery stock. Other top crops include peaches and kiwi fruit.

Soils. The soil characteristics of the County divide agriculture into two distinct sub-areas: Orchard and Field Crops, where highly productive soils permit intensive cultivation of field crops, seed crops, vegetable crops, tree and vine crops, nursery stock, and apiary and aquaculture products; Grazing and Open Lands, where soil characteristics are best suited for grazing, animal husbandry, and aquaculture products. The total County land area of 1.07 million acres contains approximately 393,720 acres or 37% of "prime to fairly good" agricultural soils, as defined by the United States Department of Agriculture Natural Resources Conservation Service.

COLUSA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Colusa County has a total area of 737,920 acres (1,149 square miles). It is bounded by Glenn County on the north, Yolo County on the south, Butte and Sutter Counties on the east, and Lake County on the west. Colusa County contains three physiographic regions: the Sacramento Valley occupies the eastern part of the county and constitutes about 47% of the area; the Coast Range foothills occupy the central to southwestern portion of the county and is about 44% of the area; the Coast Range mountain portion occupies the northwestern part of the county and is about 9% of the area.

Climate. The climate of Colusa County is characterized by warm, dry summers and cool, moist winters in the Sacramento Valley; and warm, dry summers and cold, wet winters in the Coast Range. There is a wide variability in climate due to the topography of the county. There are two weather stations in Colusa County, one located in Colusa and the other in Williams. Of these, Colusa reports slightly more precipitation with an annual average of 16.4 inches, while Williams has an average 15.6 inches each year.

Hydrology-Drainage Patterns. Elevation ranges from 7,056 feet at Snow Mountain, on the western boundary, to 35 feet at the Sacramento River, on the eastern boundary. According to the *Draft Colusa Basin Watershed Assessment,* there are 32 foothill streams drained by 24 subwatershed areas comprising the Colusa Basin Watershed area. The Sacramento River runs the length of the county north to south. Other main waterways include Stony, Grindstone, Bear, Elk, Cache, Walker, Willow, Cortina, Freshwater and Sulphur Creeks.

Land Use/Crop Types. According to the County Agricultural Commission's Report, **t**he top five crops of value in 2006 includes rice, almonds, processing tomatoes, walnuts and cattle and calf.

Large farms dominate the eastern half of the county, with much of the privately owned land following square-mile section lines. This portion of the county is relatively flat and used for cultivation of rice, orchards, and row crops. Also located in the eastern half is wildlife preserves. The western side of the county contains the Coastal Range foothills, which are often used as rangeland.

Incorporated cities in Colusa County include Colusa and Williams and the unincorporated communities include Arbuckle, College City, Grimes, Maxwell, Princeton, and Stonyford.

Soils. According to the Draft Colusa Basin Watershed Assessment there are four main landform types: Upland – rolling hilly to steep topography, Terrace land – gently sloping to undulating topography, Valley land – gently sloping, smooth topography, Valley basin land – nearly flat topography.

The soil types occurring in the watershed are:
Upland – En – residual soils of moderate and fairly shallow depth to bedrock
Terrace land – Cnm – brownish soils with moderately dense subsoils, e.g., Ramona loam
Terrace land – Cand – soils having dense clay subsoils, e.g., Placentia loam
Valley land – An – deep alluvial fan and floodplain soils Valley basin land
Valley basin land – Bnc – imperfectly drained

Upland soils. Upland soils are generally shallow residual soils that occur in rolling, hilly to mountainous topography, mostly having been formed in place through decomposition and disintegration of the underlying parent bedrock. Low to moderate rainfall can support vegetation for grazing on upland soils. Typically light brown or light gray-brown in color and fairly low in organic matter, upland soils may be subject to erosion under undisturbed and particularly where vegetative cover is removed or following disturbance. Upland soils cover the western third of the Colusa Basin Watershed area within the Coast Range foothills.

Terrace land soils with dense subsoils. Terrace land soils are formed in the older and younger valley fill alluvium occurring in the foothill valleys and on the alluvial fans sloping up from the edges of the valley and basin lands, usually at elevations of 5-300 ft above the valley floor. Terrace land soils generally have dense subsoils as the result of clay translocated into the B horizon, such that generally medium-textured surface soil transitions abruptly to underlying very dense clay soil. Terrace land soils with dense subsoils exhibit poor drainage and are satisfactory for annual grasses and shallow-rooted crops. These generally occur on the older Pleistocene alluvial deposits where sufficient time has transpired for the dense clay subsoil to develop. The

Pleistocene alluvial deposits form terraces along a narrow band on the upper fan surfaces lying along the edge of the foothills and in the upslope dissected foothill valleys from near Willows in the north to west of Zamora in the south.

Terrace land soils with moderately dense subsoils. These are usually brownish, neutral surface soils occupying the lower elevation alluvial fan surfaces where younger alluvium is present, and covered with grass or woodland grass. Terrace land soils with moderately dense clay subsoils generally occur south of Williams and east of the Colusa Basin Drain.

Valley land soils. In contrast to the relatively poorly drained terrace land soils, valley land soils are predominately well-drained alluvial soils formed in loamy alluvial fan and floodplain deposits. Valley land soils are generally brown in color and highly valued for irrigated crops. Some of these soils are slightly to moderately saline to alkali. They are located along the Sacramento River, in the area dissected in the Tehama Formation, and the oldest part of the relict Stony Creek alluvial fan lying northwest of Willows.

Valley basin soils. Valley basin soils occur in the lowest elevation parts of the watershed that are nearly flat and poorly drained. These soils are generally dark-colored and clayey, with a high water table. They are subject to frequent stormwater overflow and extended ponding and are primarily used for rice growing. Valley basin soils occur on the valley flat lying west of the Sacramento River floodplain deposits and east of the gently sloped alluvial fan deposits from the Coast Range foothills, comprising an area often referred to as a “low trough” extending from north of Willows to Knights Landing. The Colusa Basin comprises the southerly and lowest elevation part of the low trough on the valley flat. Valley basin soils also occur upslope from the rim of the Colusa Basin in the interfan basin area in the Maxwell vicinity.

EL DORADO COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. According to the U.S. Census Bureau, the county has a total area of 1,788 square miles, of which, 1,711 square miles of it is land and 77 square miles is water. El Dorado County contains the Desolation Wilderness, with Freel Peak as its highest point at 10,881 feet.

Hydrology-Drainage Patterns. The hydrology-drainage patterns vary throughout the county. In the Camino Area (area with the monitoring stations) there is no groundwater. There are pockets of perched water at certain times of the year. Rainfall or irrigation water enters the soil, moves downward until contacting hard rock (i.e. lava cap) and then moves laterally, reappearing in springs along hillsides or directly into streams. There is literally no runoff from irrigated lands due to the El Dorado Irrigation (EID) irrigation management system and deficit irrigation practiced by most of the vineyard and orchard managers. There is no leaching fraction required for salinity control, thus no leachate migration to springs and subsequent surface water courses.

El Dorado County has two main watersheds, the South Fork of the American River and the Cosumnes River.

The South Fork American River watershed encompasses 537,166 acres (about 840 square miles). This watershed extends from the headwaters at the Sierra Crest, at about 9,900 feet, downstream to the terminus at the convergence with Folsom Reservoir, maximum elevation 480 feet.

The Cosumnes River watershed encompasses 273,740 acres from the headwaters of the Cosumnes River, at about 7,600 feet, downstream close to the convergence of the North, Middle, and South Forks near State Highway 49 at 800 feet elevation.

There are no managed wetlands in El Dorado County.

Climate. El Dorado County is dominated by a Mediterranean climate - warm, dry summers and cool to cold, wet winters. Air temperatures vary widely during the year with the highest average temperature in the hottest month (July) is in the mid-90° F range. The coldest month is January, with temperatures generally between 48 and 54° F. There is no appreciable precipitation in the summer except for scattered thunderstorms. Average annual precipitation is in the form of rain and snow, ranges from 22.5 to 75 inches per year depending on what part of the county you are in, with the majority of it falling between November and March. The average frost-free period averages 100 days in most of the area decreasing with elevation. The longest frost-free period occurs along the western edge at the lower elevation.

Land Uses/Crop Types. According to the Agricultural Commissioner's Report, the top five crops of value in El Dorado County in 2006 include cattle and calves, winegrapes, apples, pasture and range, and Christmas trees.

El Dorado County has seven somewhat isolated agricultural areas. Topography, native forests, and residential communities create the isolation. The 7 Districts are identified in the El Dorado County General Plan. They are the Coloma, Gold Hill, Oak Hill, Fairplay, Pleasant Valley, Camino/Fruitridge, and Garden Valley Districts. The two monitoring stations are in the Camino/Fruitridge area. This area includes commercial fruit packing and wineries within the agricultural lands.

All of the crops in the Camino area are irrigated. There is no commercial irrigated pasture in the Camino area. The grapes grown for wine making are grown throughout the county. Many vineyards in the south county are grown without irrigation once the plantings mature and deep roots are established. Dry land farming of grapes is not possible in the Camino Area. Walnuts are also dry land farmed in other parts of the county.

El Dorado County agricultural producers grow a wide diversity of crops on a small amount of acreage using limited resources. A total of 3,494 acres of fruit and nut crops were reported in the 2006 El Dorado County Crop Report, the majority of that acreage, 2,058 acres, is planted in winegrapes, the leading commodity in the county. Most producers, other than the winegrape growers, are small farmers growing a variety of crops which they direct market. The local agricultural economy is based on value-added products from apples ("Apple Hill" is the major agritourism area in El Dorado County) and the marketing season is lengthened by the addition of stone fruits in spring and Christmas trees in the fall. Typical farm size is 5-15 acres. Apples follow winegrapes as the second leading crop in acreage with a total of 847 acres reported in 2006, followed by walnuts (219 acres) and pears (125 acres), and stone fruits: cherries, peaches and plums (247 acres collectively). Although not reported as acreage in the Crop Report, there are an estimated 500 acres of Christmas trees grown in the county and harvested at "Choose and Cut" farms (Rapetti, personal communication).

Of the seven agricultural areas, there are two major agricultural growing areas located in El Dorado County:

> *Camino-"Apple Hill"*- Apple Hill is located in the South Fork of the American River Watershed and including the Coloma and Weber Creek drainages. Crops grown in this region include the majority of the county's apple and pear acreage, winegrapes, stone fruits and Christmas trees. The El Dorado Irrigation District (EID) provides most of the irrigation water service in this area and most growers utilize the EID Irrigation Management Service for irrigation scheduling information.
>
> *Somerset-Fairplay* - Somerset-Fairplay is located in the Cosumnes River Basin and including the Middle Fork Cosumnes drainage. Winegrapes constitute the majority of crops grown here due to the lack of available irrigation water: there is no EID water in this region so growers rely on wells and springs to grow low water consumptive crops. In addition to winegrapes, there is some dry-farmed walnut, pumpkin and Christmas tree production.

Water is in short supply throughout El Dorado County. This has forced the water purveyors to implement strict water conservation measures, thus minimizing the probability for runoff of irrigation water.

There are two main water purveyors in El Dorado County on the western slope. They are El Dorado Irrigation District and Georgetown Divide Public Utility District. The designated agricultural areas served by each and/or wells are shown on Table 2. These two districts have water conservation programs, as does the El Dorado County Water Agency that covers the entire county with representatives from the Districts on the Agency Board of Directors.

The population of El Dorado County has grown rapidly in the past 20 years and much of the development is concentrated in the South Fork American River watershed. Incorporated areas in El Dorado County include Folsom, Placerville and South Lake Tahoe (not included in our Coalition area).

Soils. There are three basic soil types determining the characteristics of the region: fine-grained volcanic rock, decomposed granite and fine-grained shale.

The dominant soil orders in the major land resource area 22a (MLRA) are Alfisols, Entisols, Inceptisols, Mollisols and Ultisols. The soils in the area dominantly have a mesic, frigid or cryic soil temperature regime, depending largely on elevation, a xeric soil moisture regime, and mixed mineralogy. They are generally very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy.

The dominant soils in the MLRA formed in residuum and colluvium on hills and mountains. Soils at an elevation below 1,200 to 1,500 m include deep or very deep Haplohumults (Sites and Aiken series), Haploxeralfs (Secca, Holland, and Cohasset series), Haploxerults (Josephine series), moderately deep Haploxerults (Mariposa series), all formed in material weathered from metavolcanic and metasedimentary rocks. Deep and very deep Dystroxerepts (Chaix and Shaver series) formed in granodiorite.

Soils at higher elevations formed in residuum and colluvium include deep and very deep Haploxeralfs (Holland and Musick series), Xeropsamments (Cagwin, Corbett and Toiyabe series), Dystroxerepts (Meeks series) formed in granodiorite. Dystroxepts (Umpa series), Haploxerands (Meiss series), Vitrixerands (Waca and Windy series) formed in andesite. Large areas of rock outcrop are scattered throughout the area and on broad expanses on ridge crests and peaks above timberline 7,875 to 8,850 feet (2,400 to 2,700 m). Soils in mountain valleys formed in mixed alluvium are Dystroxerepts (Gefo and Jabu series), Argicryolls (Macareeno series), and Haploxeralfs (Inville series).

GLENN COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Glenn County covers 1,319 square miles and is located approximately 100 miles north of Sacramento. The county is bordered by Lake and Mendocino counties on the west, Tehama County on the north, Butte County to the east, and Colusa County on the south. The elevation varies from 100 to 200 feet above sea level in the vast tracts of farmland located by the river. The elevation rises from the central part of the county rapidly to the west, where mountain peaks are in excess of 6000 feet elevation. Glenn County includes a portion of the Sacramento National Wildlife Refuge, a portion of Black Butte Lake, and the Stoney Gorge Reservoir. The county has two incorporated cities: Willows, the Glenn County seat, and Orland. Major commodities include rice, wheat, hay, almonds, walnuts, corn, oranges, prunes, milk products, and livestock.

Climate. Glenn County's climate includes hot, dry summers and moderately cool, wet winters. With a temperate, Mediterranean climate, Glenn County's Orland area is the northernmost commercial citrus growing area in California.

Hydrology-Drainage Patterns. Most of Glenn County is located on the west side of the Sacramento River. Two reservoirs are operated within the county, Stony Gorge and Black Butte (partially in Tehama County). Butte County lakes, reservoirs, and swamps include: Keller Lake, Packer Lake, Stony Gorge Reservoir, Dry Lake Reservoir, East Reservoir, Forks Reservoir, Rasnor; lakes, streams, rivers, and creeks include: Zumwalt Creek, Montgomery Creek, Negro Sam Slough, Minton Creek, Mill Creek, North Fork Corbin Creek, North Fork Logan Creek, Middle Creek and Nye Creek.

Land Use/Crop Types. According to the County Agricultural Commission's Report, the top five crops of value in 2006 include rice, almonds, dairy, walnuts and prunes. Approximately two-thirds of Glenn County is comprised of agricultural cropland and pasture. According to

Glenn County General Plan Update and supporting environmental documents, the majority of the land in Glenn County currently has land use designation of "foothill agricultural/forestry" and "intensive agricultural."

According to a map entitled "Glenn County Important Farmland 1996," the eastern one-third of Glenn County is primarily a combination of prime farmland and farmland of statewide importance. This section also contains small areas of urban and built-up land. The center one-third of the county is primarily a combination of grazing land, local potential farmland, and "farmland of local importance."

Incorporated cities in Glenn County include the cities of Orland and Willows and unincorporated communities and areas include Artois, Bayliss, Blue Gum, Butte City, Capay, Codora, Elk Creek, Glenn, Hamilton City and Ordbend.

Soils. The United State Department of Agriculture Natural Resources Conservation Service (NRCS) classifies soils according to various properties using a system that groups similar soil types into the same soil series. The soil series present in the Basin includes:

Valley Land Soils: Valley land soils are predominately well-drained alluvial fan and floodplain soils. They are mapped as alluvial soils occurring in an intermediate rainfall zone (10 – 20 inches annually). They are located along the Sacramento River and in the area northwest of Willows.

Valley Basin Soils: Valley basin soils are associated with the lowest parts of the valley that are nearly flat and imperfectly or poorly drained. They are subject to overflow, used for rice growing, and are located in the low-lying areas west of the Sacramento River extending from north of Willows to Knights Landing. Most of the Drain and the three national wildlife refuges located in the Basin are on valley basin soils.

Terrace Land Soils with Dense Clay subsoils: Terrace land soils with dense clay subsoils general have a medium-textured surface soil underlain with a very dense clay soil. The transition from surface soil to subsoil is abrupt. These soils are satisfactory for grasses and shallow-rooted crops. These soils are located along a narrow band from Willows in the north to Esparto in the south.

Upland Soils: Upland soils are found in upland areas of hilly to mountainous topography. Most of the soils have been formed in place through the decomposition and disintegration of underlying parent rock. Potentially affected upland soils have a fairly shallow depth to bedrock. Low to moderate rainfall can support woodland grass, shrub grass or short grass. The central segment of the Tehama-Colusa Canal is located in this soil type.

LAKE COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Lake County is located in the central Coastal Range of Northern California approximately 80 miles north of San Francisco. County borders are mostly natural ridgelines that surround the watersheds of Cache Creek. Portions of Eel River watershed, which drain to the ocean near Eureka, are within the county's northerly reaches.

Climate. Lake County has a modified Mediterranean climate, which is typified by warm, dry summers and moist, cool winters. The average winter temperature in Lakeport is 44° F and the average daily minimum is 33° F. The average summer high temperature for Lakeport is 71° F and the average daily maximum is 91° F.

Precipitation in the Clear Lake area generally occurs only as rainfall. At lake level, the average annual rainfall is 30 inches per year, and the amount increases considerably at higher elevations. Prevailing winds are from the west and have greater velocities during the winter months. In general, mornings on the lake are calm and afternoons are breezy.

Hydrology-Drainage Patterns. This watershed is made up of two main geographical areas that create the Upper Cache Creek and the Upper Putah Creek hydrological units.

The Upper Cache Creek Hydrological Unit has two major tributaries. All secondary tributaries within this watershed are seasonal streams. Normal desiccation occurs in June and flows return as early as September or as late as December.

The smaller of the two tributaries to this hydrological unit is the North Fork of Cache Creek. The North Fork Cache Creek Watershed, consisting of almost 183,000 total acres, has no major subwatersheds. Its agricultural operations are minor. This watershed begins in the upper reaches of the northeastern boundaries in Lake County and collect to form Indian Valley Reservoir. Its small patches of agriculture are located several miles below the reservoir in what is known as Long Valley. This valley hosts one commercial nursery, small acreages of irrigated pasture and dry-farmed walnuts as well as small acreages of winegrapes that have been planted on benches and ridges.

The larger tributary to the Upper Cache Creek Hydrological Unit is the Main Fork of Cache Creek, comprising almost 295,000 acres of watershed. Its tributaries are those of Clear Lake, the largest natural freshwater lake located entirely within California. Clear Lake is believed to be the oldest lake in North America. Limnologists estimate its age to be 500,000 to 2.5 million years old. The lake acts as a collection basin for waters emanating from the western and central portions of the county. Surface area of the water body is 60-square miles and its shoreline is slightly more than 100 miles. Clear Lake is 18 miles long (7.5 miles wide at its maximum width) with a watershed of approximately 500 square miles.

Clear Lake is characterized as eutrophic with no thermocline. Depths range from 20 to 50 feet. Storage capacity is estimated to be approximately 313,000 acre-feet (af) between 0 and 7.56 feet Rumsey, the unique scale by which Clear Lake levels have been monitored for more than 100 years.

Three arms comprise Clear Lake. The Upper Arm (28,000 ac., mean depth 23 ft.) is by far the largest and the shallowest arm. The creeks of Big Valley, Middle Creek and Scotts Creek flow into this arm of Clear Lake.

To the Southeast is the Lower Arm (8,200 ac., mean depth 34 ft.) The deepest points of Clear Lake are found here, as is its drain, Cache Creek, located at its southeasterly end.

The smallest arm is the Oaks Arm (2,800 ac., mean depth 36 ft.,) that extends to the northeast. This arm is noted for its proximity to Sulphur Bank Mine, an abandoned mercury source listed as an EPA Superfund site.

It is estimated that between 46 – 53% of lake inflow is from the Scotts Creek and Middle Creek, which enter the lake through Rodman Slough. Clear Lake discharges into Cache Creek through the Clear Lake Dam, which is approximately 5 miles downstream of the lake.

Clear Lake's tributaries can be divided into the following six geographical areas listed clockwise starting at the northwestern-most point of Clear Lake:

1. **Middle Creek Watershed** including the several branches of Middles Creek as well as Lyons, Clover, Alley and Robinson Creeks and Rodman Slough;
2. **North Shore Drainage**, which includes lands that drain directly into the lake from Nice to Clear Lake Oaks and including Bartlett and Schindler Creeks;
3. **City of Clearlake** Drainage including Burns Valley, Borax Lake and Seigler Creek;
4. **Red Hills Watershed** including Mt. Konocti's northern and eastern faces as well as Thurston Lake;
5. **Big Valley Watershed** comprising the several creeks of Big Valley from the western flank of Mt. Konocti to the city of Lakeport including Manning, Adobe, Kelsey and Cole Creeks as well as several sloughs, and;
6. **Scotts Creek**, which drains a region west of Lakeport north to join Middle Creek before it enters Rodman Slough at the edge of Clear Lake.

Clear Lake is also fed by several underground streams of unknown volume that run into the lake through "vents" or lakebed springs. No surface streams descend the prominent landmark, Mt. Konocti, which rises 3,500 feet from the southern edge of Clear Lake. No surface outlet from Thurston Lake is evident.

The second main hydrological unit is that of Upper Putah Creek, which is almost 132,000 acres in size. This watershed has many small seasonal creeks that flow into Putah Creek via Soda, Coyote, Big Canyon, Harbin and Dry Creeks.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Lake County include winegrapes, pears, nursery products, walnuts, and cattle and calves. Other major agricultural land uses include rangeland or pasture, and field and seed crops including alfalfa, oat hay, grass hay, and wild rice.

The gross value of Lake County agricultural production for 2005 was $61,542,811; this was almost unchanged from 2004. The increase in the value of wine grapes countered decreases in all other agricultural categories except livestock and poultry products.

Current irrigation practices include dry-farming, which is limited to field and seed crops, rangeland, a small number of older vineyards and about half of the walnuts grown in the county. All other agricultural irrigation practices fall into the categories of drip, sprinkler or flood irrigation. Water sources are underground aquifer, retention pond or lake.

Soils. Topography of Clear Lake's watersheds is generally steep and rugged, but the watershed includes some gently sloping valleys, terrace remnants and some limited ancient lakebeds. Watershed elevations range from 4,299 feet at the top of Mount Konocti to 1,318 feet at the level of Clear Lake.

The geology of the Clear Lake watershed includes marine sedimentary rocks of the Franciscan Formation (KJf), unconsolidated Quarternary alluvium (Q), Quarternary volcanic flow rocks (Qv, Qrv), weakly consolidated Pliocene sedimentary deposits (QPc), and smaller areas of other materials. Over 70% of the soils of the watershed are shallow (i.e., less than 20 inches deep to bedrock). The shallowest soils (less than 6 inches deep) are found on steep slopes at the upper limits of the watershed. After only 3 to 4 inches of rainfall, these soils become saturated and readily produce runoff. The valleys and terraces have deep alluvial soils.

LASSEN COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Lassen County is a rural area covering 4,720 square miles. The county has all types of terrain including open valleys that are mainly agricultural, mountain meadow areas, forested plateaus, and high mountain peaks and ranges.

Climate. The climate is generally dry, warm days and cool nights, with an average summer high of 89° F and daytime temperatures in the 40's during the winter months. Average high in summer is 93° F. with an average low in the winter of 28° F. Average snowfall is 10 inches each year for the valley areas. The higher regions receive much more snow. Average precipitation is 14.29 inches.

Hydrology-Drainage Patterns. According to The California Water Plan, the majority of Lassen County is included in the North Lahontan Hydrologic Region. This means that most of the County's surface water, including the Susan River, drains to the series of alkaline lakes, such as Honey Lake, that make up the region, and do not drain to the ocean. In addition, much of the western portion of the County contributes surface water to the Sacramento River Hydrologic Region, eventually feeding the Pacific Ocean through the Sacramento-San Joaquin Delta. Other prominent water resources include Eagle Lake and a portion of the Pitt River.

Land Use/Crop Types. According to the County Agricultural Commission's Report, the top five crops of value in 2006 include alfalfa, timber, hay, strawberries, and steers. Other major crops include wheat, oats, barley, and rye. Livestock and pastureland also are significant crops. Miscellaneous crops include alfalfa seed, garlic seed, and mint. The 2006 County Agricultural Commissioner's Report indicates the total crop value was just under $33 million.

Soils. Although much of the soil in Lassen County is sandy and barren, or rendered unproductive through the presence of alkaline deposits, most of it is naturally rich and can be made to produce good crops of grain and the hardier fruits, by the aid of irrigation.

MODOC COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. The northeastern most county of the State, Modoc County, is bounded on the north by the State of Oregon, on the east by the State of Nevada, on the south by Plumas County, and on the west by Siskiyou. It is rectangular in shape, measures nearly one hundred miles east and west, by nearly sixty north and south, and contains 2,750,000 acres.

Terrain in Modoc County is rolling hills to mountain peaks with relatively flat cropland. About 70% of land in the county is under stewardship of the Bureau of Land Management or U.S. Forest Service, with Modoc National Forest making up a large portion. Another large portion of land is given over to agriculture, both farming and ranching. Populated areas make up only a fraction of the total county land area. The entire northeastern part of California, as well as parts of Oregon and Nevada exist on a lava table dating to prehistoric periods.

Climate. Modoc County's climate is typical of any high-altitude high desert region, with warm dry summers and cold wet winters.

Modoc's elevation ranges from around 4,000 feet to approximately 8-9,000 feet in the higher peaks of the Warner Mountain Range. In a climate like this, snow is possible at any time during the winter months anywhere in the county. California highway 299E winds in a northeasterly direction toward Modoc County from the Sacramento Valley floor elevation of approximately 700 feet near Redding. About 50 miles northeast of Redding, near Burney, the elevation rises to around 3,000 feet and the environment and climate begin to transition to mountainous terrain and the high desert region. This is also generally the snow line area for the western Sierra during winter months.

Temperatures begin to warm in April and May. From May to September, with temperatures the weather is hot and dry with peak temperatures in July. Temperatures begin to cool in September, often-freezing nights. Winter in earnest, with rain, snow and cold temperatures normally lasts from around Thanksgiving to March. The county's average annual precipitation, rain and snow combined, is about 17 inches.

Soils. The Pit River area contains a diverse assemblage of soil types essential to farming, ranching, timber, and wildlife resources. Soils within the subwatershed are summarized by grouping them into valley, plateau-foothill, and mountain associations. Soil associations are grouped by physiographic features, parent rock material, slope, aspect precipitation, and vegetation potential.

Valley Soils Used in Irrigated Agriculture:

Modoc-Oxendine-Bieber: Soils in this group are found primarily in the Big Valley area. Uses for this soil type include irrigated agriculture and livestock grazing.

Pittville-Dudgen-Esperanza: The soils in this group are found primarily in the Fall River Valley. This soil type uses include producing irrigated crops and livestock grazing.

Aikman-Cardon: These soils are found mainly in the Warm Springs Valley area around the town of Canby. This soil type is used for irrigated pastures and livestock grazing.

Deven-Bieber-Pass Canyon: This soil type can be found throughout the watershed. Uses include irrigated agriculture and livestock grazing.

Hydrology-Drainage Patterns. The north and south forks of the Pit River drain the northern portion of Modoc County. The North Fork of the Pit River originates at Goose Lake (Goose Lake Coalition), an enclosed basin, except during rare events when it spills over into the Pit River. The North Fork headwaters include a number of tributaries in the Warner Mountains. The South Fork of the Pit River originates in the south Warner Mountains at Moon Lake in Lassen County. The north and south forks of the Pit River converge in the town of Alturas in Modoc County and then flow in a southwesterly direction into Shasta Lake in Shasta County.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Modoc County include alfalfa, cattle and calves, potatoes, vegetable crops and timber. Other crops include hay, oats, barley, wheat, irrigated pasture, strawberry plants, wild rice peppermint, garlic, onions, and assorted vegetable seed.

Approximately one-half of the acreage in Modoc County is privately owned, with predominant uses in production agriculture including hay/alfalfa, ranching, wild rice, timber and livestock grazing. The growing season typically lasts 4-5 months. The other half is held by U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and the California Department of Fish and Game. Additionally, there is one national wildlife refuge (Modoc) is located in the northern part of the subwatershed, and another state-owned wildlife area (Ash Creek) is located in the southern Modoc County.

Irrigation practices: Agriculture is the largest water-using industry in the Pit River watershed. It has been estimated that approximately 230,000 acre-feet of surface water is diverted annually in the Pit River watershed for irrigation purposes. Various methods of irrigation are used, including wild flood, flood, pivot, wheel-line sprinklers, and hand-line sprinklers. Wild rice uses a flood method that inundates the plant under at least six inches of water throughout the entire growing season.

NAPA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Land in Napa County, totaling 230,872 acres, drains to Lake Berryessa before entering Solano County. Most of the land in the Napa County area is low intensity brushlands, rangelands, and lands used in years past for quicksilver and gold mining.

Climate. In summer, Napa County is protected from the hot weather of the Central Valley of California by the coastal mountain ranges. The Pacific Ocean provides a source of cool, moist air in summer, and this steady flow of marine air holds temperatures at a moderate level. Temperature patterns vary throughout the area because of the mountainous terrain. The range in temperature is greater in the higher mountainous valleys near Lake Berryessa. The greatest variation in temperature occurs in summer. The average daily maximum temperature in July is in the 90's at Lake Berryessa. The highest temperature is more than 110° F in the northeastern portion of the Putah Creek drainage. The average daily minimum temperatures are in the 50's throughout the county during the warm season. Winters are generally mild, but there are occasional cold spells. In January, the average minimum temperature is in the thirties throughout the county, but a low of 15° F has been recorded. Relatively warm temperatures are common in the afternoon. In January the average daily maximum temperature is in the mid-50's. The last freezing temperature in spring generally occurs in March in most areas of the county, but it commonly occurs in February in the northeastern part. The first freezing temperature in fall generally occurs in November in most of the county and as late as December in the warmer northeastern part.

Most of the annual precipitation falls during the period of November through April. The average annual precipitation ranges from 20 inches to 35 inches in the Putah drainage. The following precipitation map, taken from the NRCS Napa County Soil Survey provides a more detailed look at precipitation variation.

The growing season near Lake Berryessa is about 285 days. The vicinity of Lake Berryessa has greater climatic extremes than other parts of the county because of the mountainous terrain, which limits the effects of the Pacific Ocean.

Hydrology-Drainage Patterns. Putah Creek flows across the northeast corner, southeasterly to the Sacramento River. The Upper Putah Creek Watershed encompasses 178,477 acres in southeast Lake County and some of Napa and Solano Counties. It is approximately 35 miles in length and 20 miles at its widest point. Elevations range from 440 feet at Lake Beryessa to 4722 feet at Cobb Mountain.
The two main sub-basins in the Upper Putah Creek Watershed are: The Callayomi Valley (Middletown area) and Coyote Valley (Hidden Valley area). The main drainage is into Lake Berryessa. Tributaries include Putah Creek, Anderson Creek, St. Helena Creek, Dry Creek and Big Canyon creeks.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Napa County include winegrapes, nursery crops, cattle and calves, strawberries and livestock products.

The great majority of land use in the Napa County Putah Creek drainage is used as recreation land, dryland rangeland, forestland, and mixed-shrub hardwood. These low intensity uses account for over 98% of the acreage. In close vicinity of Lake Berryessa, residential, vacation homes, and vacation mobile homes account for the most intensive land uses.

Average annual application of irrigation waters varies from about 2 inches to 8 inches per acre. Nearly all winegrape producers practice “deficit irrigation”, under the recommendations of UC California researchers. This management scheme accounts for the relatively low irrigation applications, which are intended to boost wine grape quality. Irrigation-induced soil erosion is not considered to be a concern in drip-irrigated winegrape vineyards. Application rates are well below minimum soil infiltration rates for all mapped soils in the Putah drainage.

Runoff from farmlands is only a factor during the winter and spring rainy seasons. By the time initial runoff begins, usually in November or December, cover crops are providing ample control of runoff and erosion. Cover crops are also considered to be the most effective water quality protection measure. Cover crops provide very effective control of soil detachment, and also enhance soil infiltration rates, reducing off-farm runoff.

Soils. The NRCS soil survey of Napa County lists 25 different soil mapping units on agricultural lands in the Putah Creek drainage. Most of these soils are upland soils and alluvial soils based in the Great Valley rock sequence of ancient marine sandstones and shales, and ultramafic serpentinic rocks. A smaller portion of lands closer to ridgelines bordering the Napa River watershed are comprised of soils derived from igneous parent materials of the Sonoma Volcanics.

The erosion potential of these soils is variable. Depending on slope and soil “K” factor erodibility, most agricultural is developed on lands with low to moderate erosion potential. Most hillside vineyards employ cover crops and various methods of storm runoff control practices to reduce soil erosion potential.

NEVADA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Nevada County is 978 square miles and encompasses everything from gently rolling hills and meandering streams with a smattering of oak and pine trees to majestic forests with sheer cliffs and raging rivers. There are two main population centers in Nevada County, within the Coalition boundary, Nevada City and Grass Valley.

Climate. The average rainfall in Western Nevada County is 54 inches and the average snowfall is 21 inches. The average high temperature is 68° F with an average low of 40° F.

Hydrology-Drainage Patterns. Nevada County has three major drainage basins or watersheds, the Yuba, Bear, and Truckee (not within the Coalition boundary). The Yuba and Bear rivers originate near the Sierra Crest and drain into the Feather River which in turn drains into the Sacramento River.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner’s Report, the top five crops of value in Nevada County include timber, heifer and steers, winegrapes, irrigated pasture and pasture and range. Pesticide use is low in Nevada County ranking 48 out of 58 counties.

Soils. Croplands generally occur on deep, fertile soils in alluvial valley bottoms or gently rolling terrain in the low to mid-elevations of Nevada County.

The majority of the agricultural lands in Nevada County are irrigated and dryland pasture that are on the most fertile soils, often near or on the floodplain of a stream.

Small acreages of hay and vegetable crops also are grown in the county. The vicinity of Pilot Peak near Penn Valley contains a high proportion of higher quality farm soils than many other areas in Nevada County. Areas mapped as croplands in the county occur between about 1,175 feet and 2,980 feet elevation.

Orchards in Nevada County are often found within Annual Grasslands, Montane or Foothill Hardwood Woodlands, or Ponderosa Pine Forest. They are also frequently adjacent to streams or irrigation canals. Deep, well-drained soils of volcanic origin and gentle to moderately sloping hills in the middle elevations are characteristic of orchards in Nevada County. Loamy soils mapped as “Aiken” and “Cohasset” series are the most common or preferred substrate for orchards, and they range in elevation from about 1,400 feet to about 3,000 feet in Nevada County.

Rolling hills of deeper, well-drained soils in the middle elevations are the most likely setting for Vineyards in Nevada County. Locally, they occur on well-drained metamorphic soils mapped as “Sites loam” and granitic soils mapped as “Sierra sandy loam”, although other soils are also represented.

PLACER COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Auburn Ravine originates north and east of the City of Auburn in the Sierra Nevada foothills. Elevation of this basin ranges from 30 to 1,600 feet above mean sea level. Auburn Ravine flows from rural residential and intermittent agricultural areas through the urban City of Auburn. Auburn Ravine is channelized through the City, passes through a variety of culverts and is contained in a highly restricted natural channel. Auburn Ravine continues to flow through western Placer County to the City of Lincoln and then into the rural agricultural lands.

Coon Creek originates near Clipper Gap and is primarily composed of two intermittent tributaries, Dry Creek and Orr Creek, which merge to form Coon Creek approximately one mile west of State Highway 49. Coon Creek avoids the most heavily urbanized portion of the City of Auburn. Down stream of this juncture, Coon Creek has continuous flow because discharge from Placer County’s wastewater treatment plant on Joeger Road flows into Rock Creek and then into Dry Creek. The stream continues through rural agricultural areas until near McCourtney Road. The character of the stream changes as it moves into the valley floor.

Markham Ravine originates in the low elevation hills northeast of the City of Lincoln and has a poorly defined channel. This subshed passes through industrial, light industrial and rapidly urbanizing areas located in the western side of the City of Lincoln.

Climate. According to the U.S. Department of Agriculture (USDA) Soil Survey of Placer County, Western Part, Placer County has abundant sunshine in summer and receives moderate to heavy precipitation winter. The Sierra Nevada Range largely determines the climate of Placer County. The average annual air temperature is approximately 62° F at the lower elevations. The average minimum temperature in January is approximately 39° F and the average maximum July temperature is approximately 96 degrees in the lower elevations. The growing season ranges from about 180 to 280 days. Precipitation in the driest part of the Soil Survey area is about 18 inches.

Hydrology-Drainage Patterns. The following description of water resources is, in part, original text from the Auburn Ravine Coon Creek Restoration Plan and information from USDA Soil Survey of Placer County. These watersheds are relatively small; very little flow is from natural runoff. For the most part, stream flow is water imported from the Yuba, Bear, and American River watersheds through various diversions to meet agricultural, municipal and industrial needs. Sources of available water are the Nevada Irrigation District, Pacific Gas and Electric Company, South Sutter Water District, and Placer County Water Agency.

Winter flows are dominated by discharges from wastewater treatment facilities and runoff from rainfall events. Summer flows are dominated by irrigation water deliveries to farms, golf courses, and small ranches on the valley floor. Winter flows vary between these watersheds from a few hundred cubic feet per second to more than an estimated 22,000 in a one hundred year event. Flooding does occur in major events and is influenced by the East Side Canal.

Land use/Crop Types. According to the Agricultural Commissioner's report the top five crops by value in 2006 were nursery products, timber, cattle and calves, rice and walnuts.

A significant amount of land in these watersheds is privately owned. Some exceptions include the Western Regional Sanitary Landfill near Fiddyment Road and the small U.S. Air Force property adjacent to Moore Road. Rapid urbanization in the cities is based upon a general policy that development is most suited to occur within the Cities of Roseville, Rocklin and Lincoln.

Mixed land use of rice, irrigated and non-irrigated pasture, fruit tree crops, and livestock. Includes 4 incorporated cities (Roseville, Rocklin, Lincoln, and Auburn) and 4 unincorporated urbanized areas (Granite Bay, Newcastle, Loomis and Penryn).

Soils. Placer County soil types meeting the criteria for Prime Farmland as outlined in the U.S. Department of Agriculture's Land Inventory and Monitoring (LIM) Projects include:
Aiken loam; Cohasset loam; horseshoe gravelly loam; Josephine loam; Kilaga loam; Ramona sandy loam; Sierra sandy loam; sites loam; and xerofluvents. Placer County soil types meeting the criteria for Farmland of Statewide Importance as outlined in the U. S. Department of Agriculture's LIM project include: Aiken loam; Alamo Variant clay; Andregg coarse sandy loam; Boomer loam; Cohasset loam; Cometa sandy loam; Cometa-Ramona sandy loam; Josephine loam; Sobrante silt loam; sandy and hardpan substratum xerofluvents.

PLUMAS COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Plumas County is a county located in the Sierra Nevada of the U.S. state of California. The county gets its name from the Spanish words for the Feather River (Río de las Plumas), which flows through the county. As of 2000, the population was 20,824. The county seat is Quincy. The only incorporated city in the county is Portola.

Climate. The average rainfall is 34 inches and the average snowfall is 133 inches. The average high is 70° F and the average low is 38° F.

Hydrology-Drainage Patterns. The North Fork Feather River is one of three forks of the Feather River system in northern California. This system consists of North, Middle, and South forks, all of which originate in Plumas County and flow into Lake Oroville reservoir; after exiting Lake Oroville the Feather River runs south through the northern Sacramento Valley and eventually ends in a confluence with the Sacramento River.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Plumas County include timber, stockers and feeders, alfalfa, irrigated pasture and forage pasture.

Soils. Not available at time of printing.

SACRAMENTO COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Sacramento County is 995 square miles and has a relatively flat topography in the valley increasing to rolling hills the further east you travel. Sacramento County is bounded on the west by the Sacramento River and Yolo County, to the east by Amador County, to the north by Placer County and to the south by San Joaquin County.

Climate. Sacramento County has a Mediterranean type climate, characterized by dry summers and cool, moist winters. The subwatershed is protected from extremes to the east by the Sierra Nevada and to the west by the Coast Range. In Sacramento County, cool moist winds often travel up the Carquinez Strait into the Sacramento Valley moderating the maximum temperatures in summer. As a result of the cooling effect of the summer winds in the Delta, daily July temperatures averages 91.2° F, while the more inland area such as Folsom in northeast Sacramento County averages 97.1° F. Occasionally in summer a high-pressure system produces north winds and blocks the cool Delta breeze, producing low-humidity heat waves. In winter, a southward shift of the high pressure allows weather systems to enter the county, producing cool moist weather.

In Sacramento County, average annual precipitation ranges from 15 to 24 inches. Rainfall totals increase as elevation increases in the eastern and northeastern parts of Sacramento County.

The annual rainfall at the confluence of the Mokelumne and the Cosumnes Rivers, the southwest portion of the subwatershed, averages 15 to 17 inches while Folsom, in the northeast, averages

24 inches. Approximately 80% of annual rainfall occurs between November and March. Of this, 55% falls in December, January and February. Only an average of 1% of annual rainfall occurs in June, July and August.

Hydrology-Drainage Patterns. The natural drainage in the Sacramento County generally flow east to west or to the southwest. Main drainages in Sacramento County include the Sacramento River, American River, Cosumnes Rivers, and Dry Creek. There are two main tributaries to the Cosumnes River: Deer Creek and Laguna Creek. Additionally, the Cosumnes River splits into the Lower Fork, Middle Fork and Upper Fork of the Cosumnes; the Lower Fork is in Amador County and the Middle and Upper Forks are in El Dorado County.

Portions of the virtually unregulated Cosumnes River dry up in the summer. Most creeks in the Sierra Nevada and the Sacramento Valley are intermittent. During the winter, levees provide flood protection along the Cosumnes River in the lower subwatershed.

Below the I street bridge in Sacramento County is the legal Delta containing several farmed islands.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Sacramento County include winegrapes, milk, nursery products, pears and poultry. Agriculture is the dominant land use in the southern and southeastern portion of the county with a small amount in the north.

Main urban areas are the city of Sacramento, Citrus Heights, Folsom, Elk Grove and Galt. Sacramento, Citrus Heights, and Folsom are all located in the Placer – North Sacramento Subwatershed, while Elk Grove and Galt are located in the Sacramento-Amador Subwatershed.

Soils. Soils in the Sacramento County can be categorized into eight general mapping groups. They are: (1) Very deep, Nearly Level to Steep Soils in Areas of Dredge Tailings, (2) Very Deep, Nearly Level Soils in Freshwater Marshes and Backswamps, on Natural Levees, and on Low and High Floodplains, (3) Urban Land and Very Deep, Nearly Level Soils on High Flood Plains, Low Stream Terraces, and Low Terraces, (4) Nearly Level Soils in Basins and on Basin Rims, (5) Nearly Level to Gently Rolling Soils on Low Terraces, (6) Urban Land and Nearly Level to Steep Soils on Hills and in Filled Area, (7) Nearly Level to Hilly Soils on High Terraces and Hills, and (8) Undulating to Hilly Soils on Foothills.

1) Very Deep, Nearly Level to Steep Soils in Areas of Dredge Tailings are found in two small areas in the eastern part of Sacramento County near the Amador County line. Elevation ranges from 80 to 400 feet above sea level. They consist almost entirely of cobble and gravel. These soils are mainly used for wildlife habitat and urban development. The main soil-mapping unit is Xerothents, which describes excessively drained and somewhat excessively drained soil.

2) Very Deep, Nearly Level Soils in Freshwater Marshes and Backswamps, on Natural Levees, and on Low and High Floodplains soils are found adjacent to major rivers and channels and in the Delta. They range in elevation from 20 to 140 feet above sea level. These soils are either

protected by levees or subjected to flooding. The soils are very deep and poorly to somewhat poorly drained. Both mineral and organic soils are found in this group. These soils are often stratified. The surface layer is commonly muck, mucky clay, clay loam, sandy loam or clay. These soils are mainly used for irrigated hay and pasture or urban development. Columbia-Cosumnes is the only soil in this mapping units found in the Sacramento - Amador Subwatershed and is located below Highway 16 between the Cosumnes River and Deer Creek.

3) Urban Land and Very Deep, Nearly Level Soils on High Flood Plains, low stream terraces, and low terraces soils are along the Cosumnes River and other streams. These soils range in elevation from 30 to 200 feet above sea level. Most of these soils are protected from flooding by levees or dams. The soils are well drained. Soils on the high floodplain are fine sandy loam, while the terraces have a surface layer of silt loam or loam and subsurface soil of silt loam or clay loam. The soils are primarily used for irrigated crops and wildlife. Roosmoor-Vina is the only soil in this mapping unit found in the Sacramento portion of the Sacramento – Amador Subwatershed soil-mapping units.

4) Nearly Level Soils in Basins and on Basin Rims soils are found in small quantities in the western most part of the subwatershed. They range in elevation from sea level to 30 feet above sea level. Soils are protected by levees. The soils are moderately deep or deep and somewhat poorly drained. The soils are mainly used for irrigated crops, hay and pasture, or for wildlife. A few areas are urbanized. The only soil-mapping unit is the Clear Lake soil.

5) Nearly Level to Gently Rolling Soils on Low Terraces extend north to south through the central and western parts of the lower subwatershed. These soils are the most extensive geomorphic surface within the lower subwatershed. They range in elevation from 10 to 170 feet above sea level. Typical soils of the terraces are moderately deep, moderately well drained soils that are moderately deep over a cemented hardpan. They have a surface layer of silt loam and have a claypan with a high shrink swell potential. These soils are mainly used to irrigate pasture and cropland, urban development, and rangeland. The main soil-mapping unit in the Low Terraces is the San Joaquin soils.

6) Urban Land and Nearly Level to Steep Soils on Hills and in Filled Area soils are found in the eastern part of Sacramento County, extending from the northern end to the southern end. They range in elevations from 50 to 400 feet above sea level. These soils are very shallow to very deep and are moderately to well drained. They are underlain by consolidated sediments or have cemented hardpans underlain by sediments. These moderately deep soils have a surface layer of gravelly loam or fine sandy loam and are underlain by claypan. The very shallow or shallow soils are sandy loam or fine sandy loam. These soils are used mainly for rangeland and wildlife habitat. Primary soil-mapping units are Vleck-Mokelumne and Pentz-Hadselville.

7) Nearly Level to Hilly Soils on High Terraces and Hills are located in the eastern portion of Sacramento County. They range in elevation from 40 to 390 feet above sea level. These soils are moderately deep and well to moderately well drained. They have a subsoil of sandy clay loam, gravelly clay or claypan. Some of the soils are underlain by cemented hardpan at a depth of 20 to

40 inches. These soils are mainly used for rangeland or wildlife habitat with a few urban areas. The soil-mapping units are Redding-Corning-Red Bluff.

8) Undulating to Hilly Soils on Foothills soils are found in the northeastern part of Sacramento County. They range in elevation from 140 to 830 feet above sea level. These soils are very shallow to moderately deep and are somewhat excessively drained and well drained. They are loams in the upper part and underlain by hard or weathered bedrock. Some have moderately deep soils with a claypan. These soils are mainly used for rangeland, urban development or wildlife habitat. Auburn-Whiterock-Argonaut are the main soil-mapping units in this area.

SHASTA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Shasta County is framed by Siskiyou County to the north and Tehama and Plumas counties to the south. Surrounding these counties is the convergence of the Klamath and Coastal Mountain Ranges in the northwest and west and the Cascade Mountain Range in the northeast and east.

Climate. The Mediterranean climate in the Shasta County is characterized by cool, wet winters and dry, hot summers. Shasta County ranges in elevation from 400-10,466 feet. Annual precipitation in Redding is 33.3 inches, usually between November and March with average summer highs of 90°F + and average winter highs in the low 50's. During winter storms, precipitation is concentrated at the upper end of the valley around the convergence of the mountain ranges. Typically, the western slopes receive considerably more rain than the eastern mountains.

The growing season averages from 172 to 205 days. The first frost can be expected in the middle of November and the last frost around the first of March. In the higher elevations, the frost-free growing season can be as low as 70 days. Dominant winds are north-northwest and south-southwest and they can blow from two to forty miles per hour. Dry north winds are common in late spring, summer and fall. Soils and vegetation are rapidly dried out by this hard wind.

Hydrology-Drainage Patterns. Shasta County waterways drain naturally into the Sacramento River. Shasta County lies at the headwaters of the State's largest watershed, the Sacramento River Basin. About 6.5% (5.8 million acre-feet) of all surface runoff in the State of California originates within Shasta County representing more than one-fourth of the total surface runoff within the Sacramento River system.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Shasta County include timber, stockers and feeders, hay, strawberry plants, and wild rice. Other crops include orchards, field and forage crops, eucalyptus, alfalfa/grass, small grains grown either for hay, green manure crops, or grain, and English walnut. Agriculture is not a dominant industry in Shasta County, but it does account for an important segment of the County's economic base.

Soils. Soils can be categorized into three groups: (1) the floodplain and terrace soils; (2) the foothill soils; and, (3) the mountain soils. The soils differ from each other, depending upon which side of the Sacramento River they are located.

Floodplain soils form the nearly level and very gentle slopes along the Sacramento River and its tributaries. These soils are deep to very deep. Elevations range from 250 to 500 feet. Most of these soils have been graded, are irrigated and under intense cropping. Terrace soils are mostly west of the Sacramento except in an area east of the Sacramento River and around Vina and Los Molinos. The terraces are 300 to 800 feet in elevation. The eastern Terraces are cobbly, shallow soils and not very productive. Western terrace soils are deeper and more productive. Many terrace soils have been graded, are irrigated and support a variety of field and orchard crops. The flood-plain and western terrace soils represent the county's most productive soils.

Foothill soils lie both east and west of the Sacramento River and vary from shallow to deep. In the west, they occupy a large area between the terrace and mountain soils. These soils are medium to fine textured and are moderately steep to very steep. The western foothills soils were formed from softly consolidated sediments, sediments, sandstone, and hard shale. Elevation ranges from 500 to 2,000 feet. To the east, the foothill soils are shallow to moderately deep rocky loams formed from volcanic rock. Their elevation ranges are from 500 to 4,000 feet. Eastern foothill soils are less susceptible to erosive forces.

Mountain soils lie in the far most eastern and western areas of the county. Elevations are greater than 3,000 feet. These soils support mostly coniferous forest.

SIERRA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Sierra County, 962 square miles, is a county located in the Sierra Nevada Range. Sierra County is bordered on the north by Lassen and Plumas counties, Yuba County on the west, Nevada County to the south and the state of Nevada to the east. The only incorporated city in the county is Loyalton; unincorporated towns include Sattley, Sierraville, Downieville and Sierra City.

Climate. The average rainfall is 43 inches while the average snowfall is 31 inches. The average high is 70° F with an average low of 38° F. Temperatures are typically warm in the summer months with average maximum monthly temperatures occurring in July at approximately 84º F in Sierraville with maximum temperatures recorded in August at 104º F. Temperatures in winter months average from 30º F in Sierraville. Temperatures in Loyalton range from an average low of 17º F to an average high of 84 º F. On average, the warmest month is July. The highest recorded temperature was 104° F in 1981. December is the average coolest month. The lowest recorded temperature was -29° F in 1972. The maximum average precipitation occurs in January.

Hydrology-Drainage Patterns. The Sierra Valley watershed is the headwaters of the Middle Fork of the Feather River.

Land Use/Crop Types. Ranching, farming, and timber are the primary resource activities throughout the County. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Sierra County include timber, stockers and feeders, irrigated pasture, forage pasture, and alfalfa.

Soils. In Sierra Valley, the soils are mostly Pachic and Aquic Argixerolls, Aridic Haploxerolls, Typic Haplaquolls, and Aquic Natrargids, plus Abruptic Xerollic Durargids on alluvial fans on the east side of the valley. The soils are well to poorly drained. Soil temperature regimes are mesic. Soil moisture regimes are xeric on the west side, commonly aquic on the basin floor, and aridic on the east side of the valley.

SOLANO COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Solano County is located in the lower part of the west side of the Sacramento Valley. The county boundaries are formed by Putah Creek on the north, Yolo County and the Sacramento River on the east, Suisun and San Pablo Bays on the south, and Napa County on the west. Solano County has a land area of 526,720 acres (823 square miles).

Solano County is characterized by varying topography and land use. The eastern half of the county is nearly level and is farmed under intensive irrigated agriculture. The western one-fourth is hilly to very steep and is used mostly for range. The southeastern one-eighth is rolling hills and is used for dryland small grain and rangeland. The south central one-eighth of the county is marshland and is used mostly for waterfowl hunting.

Solano County is served by two California Regional Water Quality Control Boards. The western portion (40% +/-) of the county is in the San Francisco Bay Region 2 and the eastern portion (60% +/-) of the county is in the Central Valley Region 5.

Climate. The climate of Solano County is strongly influenced by its location and topography. The Sacramento Valley, to the east and north, has hot, dry summers and cool winters; the area near the Pacific Ocean, to the south and west, has cool, humid summers and moderate winters. In the summer there is a steady marine wind that blows up the Carquinez Strait. The moderating influence of the marine air is reflected in the average annual temperatures, which is 58° F in the vicinity of the strait but is 61° or higher in the somewhat protected northern parts of the county. These differences are most pronounced in midsummer. The July average maximum is about 80° F in the San Pablo Bay area but reaches 96° F or more in the Lake Solano-Winters area. Average minimum temperatures are more uniform, ranging from 55° F in the south to 58° F in the northwest. In January the average maximum temperature is 53° F and the average minimum is 38° F near the water and 36° F inland.

Average annual precipitation for the county ranges from 16 inches in some of the southern parts of the county to as much as 30 inches at the top of the Vaca Mountains. About 17 to 20 inches falls on the eastern half of the county. Approximately 95% of the precipitation falls during the months of October through April. During the winter the daily relative humidity varies from about

90% at night to about 70% in the afternoon. When the humidity is near 100%, periods of fog occur and last several days to 2 weeks or more. In July the relative humidity averages about 75% in the early morning and drops to 55% in the afternoon with the influx of the marine air, and to about 35% in the drier interior. During this time, dry north winds can cause the humidity to drop below 10%.

The sun shines 75% of the daylight hours during July. The growing season for Solano County ranges from 240 to 300 days. The lowest is located in the uplands at the higher elevations.

Irrigation is required to obtain good growth of most crops. Dry-farmed grains are planted early in winter and harvested in June and rely on rainfall for moisture. Range consists primarily of annual grasses and forbs. Growth of these plants is limited to the first winter rains after germination and until the latter part of May. The kind of plants that grow and how well they grow depends on the amount and distribution of the rainfall and the temperature. Such undesirable plants as star thistle and tarweed are encouraged to grow by late spring rains after the annual grasses and grain have matured.

Hydrology-Drainage Patterns. The western part of the county consists of hilly to very steep mountainous uplands of the Coastal ranges that have a maximum elevation of 2,819 feet above sea level. The rest of the county is on the floor of the Sacramento Valley. Except for an isolated area of low, rolling hill in the southeast corner of the county, the valley areas of Solano County are level or gently sloping alluvial plains and marshes. They are near sea level along the eastern and southern borders and rise to an elevation of about 100 feet at the foot of the mountains. A large area of tidal flats and marshland is adjacent to the Suisun Bay. This area has been cut into islands by a maze of natural drainage channels. About two-thirds of Solano County is drained eastward to the Sacramento River by a number of intermittent streams, such as Putah, Sweeney, and Ulatis Creeks. The later two creeks are part the improved Ulatis Flood Control Project and serve as agricultural drains. This region is also served by many smaller drainage projects that serve the agricultural lands and drain to the Sacramento River. The rest of the county is drained southward into Suisun Bay by intermittent streams, such as Green Valley, Suisun and Ledgewood Creeks.

Solano County has three main sources of fresh water – Lake Berryessa, ground water, and the several sloughs that empty into the Sacramento River. Lake Berryessa, which was formed by the Monticello Dam on Putah Creek, has a potential to supply an estimated 247,000 acre-feet of water to Solano County each year. Of this, 219,800 acre-feet of water is used for irrigating about 70,000 acres of farmland. Irrigation water for the remaining 74,200 acres in irrigated farms comes from wells and the sloughs that empty into the Sacramento River. The ground water supply is replenished by Putah Creek in the northern part of the county and by the Suisun and Green Valley Creeks west and north of Fairfield.

Land Use/Crop Types. According to the 2007 Agricultural Commissioner's Report, the top five crops of value in Solano County include nursery stock, alfalfa, processing tomatoes, cattle and calves, and walnuts.

Solano County is intensively cultivated and used mainly for irrigated row crops, field crops, and orchards. In a few small areas, remnants of native vegetation remain. The rolling hills in the southeastern portion of the county are used for dryland grain and for pasture of annual grass. The mountainous uplands are used for rangeland and have a cover mainly of annual grasses and oaks.

Soils. The 17 soil associations in Solano County are placed in four major groups on the basis of slope, drainage, class, and the physiographic position of the soils on the landscape. These four groups of associations are:

Nearly Level to Moderately Sloping, Well-Drained to Somewhat Poorly Drained Soils on Alluvial Fans: These soils are loams to silty clay loams. They formed in alluvium from mixed rocks that were mostly sedimentary. Slopes are 0 to 9%. Elevation ranges from 25 to 250 feet. The average annual temperature is 58° to 62° F, the average annual rainfall is 18 to 25 inches, and the frost-free season is 240 to 280 days. Most of these soils are cultivated. The three soil associations in this group make up about 15% of Solano County. These soil associations are Yolo-Brentwood, Yolo-Sycamore, and Rincon-Yolo.

Nearly Level to Gently Sloping, Moderately Well Drained to Very Poorly Drained Soils on Basin Rims, Alluvial Fans, and Deltas, and In Basins, Dredged Spoil Areas, and Salt Water Marshes: These soils are silty clay loams to clays or mucky clays, or they are mucks or peaty mucks. They formed in mixed alluvium, mostly derived from sedimentary rocks or from hydrophytic plant remains. Slopes are 0 to 5%. Elevation ranges from 10 below sea level to 125 above sea level. The average annual temperature is 58° to 62° F, the average annual rainfall is 15 to 22 inches, and the frost-free season is 240 to 290 days. The vegetation is annual grasses, forbs, sedges, perennial herbs, and hydrophtes. The six soil associations in this group make up about 33% of Solano County. These soil associations are Capay-Clear Lake, Sacramento, Egbert-Ryde, Valdez, Joice-Suisun, and Reyes-Tamba.

Nearly Level to Moderately Steep, Well-Drained to Somewhat Poorly Drained Soils on Terraces and in Basins: These soils are gravelly loams to clays. They formed in alluvium derived mostly from mixed sedimentary rocks. Slopes are 0 to 30%. Elevation ranges from 5 to 250. The average annual temperature is 58° to 62° F, the average annual rainfall is 16 to 25 inches, and the frost-free season is 250 to 280 days. Where these soils are not cultivated, the vegetation is annual grasses, forbs, and some salt tolerant plants. The three soil associations in this group make up about 17% of Solano County. These soil associations are San Ysidro- Antioch, Corning, and Solano-Pescadero. Gently Sloping to Very Steep, Well-Drained and Somewhat Excessively Drained Soils on Dissected Terraces and Mountainous Uplands: These soils are loams or stony loams to clays. They formed in materials weathered from weakly consolidated sediments, sandstone, or basic igneous rocks. Slopes are 2 to 75%. Elevation ranges from 25 to 3,000 feet. The average annual temperature is 54° to 62° F, the average annual rainfall is 15 to 40 inches, and the frost-free season is 220 to 280 days. The vegetation is mostly annual grasses and forbs, but some areas are covered by brush or scattered oaks. The five soil associations in this group make up about 35% of Solano County. These soil associations are Altamont-Diablo, Dribble-Los Osos, Millsholm, Maymen-Los Gatos, and Hambright-Toomes.

SUTTER COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Sutter County's jurisdictional boundaries are generally defined by Yolo and Colusa Counties to the west with the Sacramento River and Butte Slough forming the western boundary; Butte County to the north; Yuba and Placer Counties to the east with the Feather and Bear Rivers forming the eastern boundary; and Sacramento County to the south. The County encompasses approximately 607 square miles (388,358 acres), which can be divided into two general topographical areas: a valley area and the Sutter Buttes.

Climate. Sutter County has a mild climate. Temperatures range from lows, around 36° F in January, to summer month highs, around 96.4° F. The County receives an average annual rainfall of 30.0 inches.

Precipitation occurs primarily between November and April when 88% of the average annual rainfall is received. Annual averages vary for the County from 17 to 21 inches. Annual rainfall increases across the area from the southwest to the northeast.

Hydrology-Drainage Patterns. Sutter County topography is a relatively flat alluvial plain with the exception of the Sutter Buttes and the surrounding rolling terrain. The eastern part of the County is an alluvial terrace with elevations of 35 to 80 feet. This terrace generally drains to the southwest into the lower Sutter and American Basins, which are at 10 to 40 feet elevation. Drainage generally is provided by ditches and pumping plants that elevate the water over the levees of the Sacramento River.

The Sacramento River provides drainage for all of Sutter County and the Sacramento Valley through a system of levees and bypasses completed in the 1920's. In winter and spring, floodwater from various rivers and drainageways is controlled by this system. The final outlet of the water is the Delta and San Francisco Bay.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Sutter County include prunes, rice, walnuts, cling peaches and milk.

There are two incorporated cities in Sutter County. They are the City of Yuba City and the City of Live Oak. There are several unincorporated "rural communities." They are Meridian, Nicolaus, East Nicolaus, Rio Oso, Robbins, Sutter and Trowbridge. The county is a short drive from the Interstate 80 and 5 corridors and is served by State Highways 20 and 99.

Sutter County is predominantly an agricultural county. The 2002 Census of Agriculture classifies 96% of the county's total acreage as agricultural. The county's valley floor location between two major rivers combined with its rich agricultural soils and inland climate provides for a long growing season. Agricultural activities within the county fall into two categories: 1) intensive agriculture, defined as all agricultural practices involving cultivation of the land for the production of field crops, seed crops, vegetable crops, fruit and nut crops, nursery stock, and apiary products, and 2) extensive agriculture, which involves animal husbandry forms of agriculture. The map on the following page illustrates the different types of agricultural land within the county. http://www.yubacity.net/documents/News-Events/Multi-Hazard-Mitigation/MultiHazardSection41HazardID2.pdf

Soils. The soils of Sutter County vary in productivity. This variation is based upon different qualities of the soils found in the County. In 1986, the U.S. Soils Conservation Service (SCS) published the "Soil Survey of Sutter County, California". That survey classified each of the soil groups in Sutter County based upon the SCS Land Capability Classification System. The SCS system, which is based on effective soil depth, texture, water retention characteristics, slope, erosion potential, drainage and alkalinity-salinity factors as they relate to climate and precipitation, is the most universally recognized agricultural soil classification system. As shown in Table 9.2-5, soils are divided into eight classes indicated by Roman numerals based on these characteristics. Soils in Classes I through IV are considered suitable for cultivation, while soils in Classes V through VIII are generally unsuited for agriculture, although these soils may be used for range, watershed, wildlife and other non-intensive agricultural uses. Class I and II soils are considered "prime" agricultural land, Class III soils are considered "good", and Class IV soils are considered "fairly good" for agricultural use.

Based on the SCS classification, 47.6% (184,800 acres) of the area of Sutter County would be classified as prime agricultural soils if an adequate and dependable source of irrigation were available. Under the 1989 State Farmland Mapping Project, another 23.5% (91,220 acres) has soils of statewide importance. Together, these two soil groups, prime agricultural soils and soils of statewide importance, compose over 71% (275,998 acres) of the total area of Sutter County and comprise the most important agricultural lands of the County.

TEHAMA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Tehama County's location in the upper Sacramento Valley has cultivated its development as an agrarian and rural community. Tehama County is located in the northern Sacramento Valley. The western boundary of Tehama County is located in the Pacific Coast Range, and the eastern boundary is in the Cascade Mountains. The County is approximately 2,950 square miles and contains rolling foothills, fertile valleys, flat-topped buttes, and vast rangelands. Surrounding counties include Shasta County to the North, Plumas and Butte Counties to the east, Glenn County to the south, and Trinity and Mendocino Counties to the west. Tehama County is generally bisected by the Sacramento River Valley, which cuts a 20-mile-wide swath through the central portion of the County. Additionally, the County contains large amounts of National Forests in the hills and mountains to the east and west.

Climate. The climate of Tehama County varies significantly between the valley and mountain areas, depending primarily on elevation. Hot, dry summers and temperate winters generally characterize the valley regions, while mountainous areas experience warm, dry summers and colder winters. In Red Bluff, July's average daytime high temperature is 98°F. January's average daytime high is 55°F. Annual average snowfall is 2 inches.

Land use/Crop Types: According to the Agricultural Commissioner's report the top crops by value in 2006 are walnuts, prunes, almonds, livestock and poultry and timber. Other crops include olives, pecans, pistachios, peaches, figs, winegrapes, alfalfa, oats, barley, and wheat grown for hay, forage, or as green manure crops, wheat, corn, dry beans, rice, vegetables, and berries.

Recently in Tehama County, growth pressures from outlying counties have spurred new housing and commercial developments.

Soils. According to the Tehama County General Plan, soil types and their characteristics in Tehama County vary in part by location, i.e., valley or hillside. The principal soil series in Tehama County is the Tehama Series. Soils of this series have formed on the nearly level to gently sloping, deep alluvium of the Valley. The soils are well drained to somewhat poorly drained loams, silt loams, and clay loams on flood plains, alluvial fans and terraces. Located along the alluvial plains of the Sacramento River and its tributaries, and generally between State Highway 99 and Interstate Highway 5 between Red Bluff and the southern County boundary, these soils are among the most agriculturally productive in the County. Soils in the foothill and mountain areas are less productive and commonly used for grazing.

YOLO COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Yolo County is in the lower part of the Sacramento Valley. It has a land area of 661,760 acres (1,034 square miles).

Climate. Yolo County has a Mediterranean climate characterized by warm, dry summers and cool, moist winters. The annual temperature ranges from 50° to 62° F; the maximum temperature, from 95° to 98° F; and the extreme temperature, from 110° to 117° F. The southern part of the county is cooler than the north-central part because cool air from the ocean flows through the Carquinez Strait into the Sacramento Valley in summer.

Annual rainfall is 16 to 24 inches. Rainstorms move eastward from the Pacific Coast into the county in winter and early in spring, but rains occur infrequently in summer. The heaviest rainfall occurs in the Coast Ranges, as well as infrequent snowfall of short duration.
Wind*:* Wind direction depends on the orientation of the Sacramento Valley and the flow of marine air from the Carquinez Strait. The wind blows from the south two-thirds of the time, and from the northeast for much of the remaining time.

Relative humidity in winter is about 90% at night and about 80% during the day. The combination of low wind velocities, cold air drainage from the surrounding uplands, and relatively moist, warm soil causes fog to form in the Sacramento Valley that lasts from several days to several weeks and is known locally as tule or valley fog. Relative humidity in summer and early in fall is 25 to 40% during the day. The sun shines 95% of the daylight hours during July and August.

The growing season is about 230 to 280 days long. It is lowest in the uplands at the higher elevations. Irrigation is needed to obtain good growth of most crops. Dry-farmed grain is planted early in winter and is harvested in June, relying on rainfall for moisture. In some areas soils are double-cropped, (dry-farmed grains are followed by a fall-harvested row crop). Range consists primarily of annual grasses and forbs. Growth of these plants is limited to the first winter rains after germination and until the latter part of May. The kind of plants that grow and how well they grow depends on the amount and distribution of the rainfall and the temperature. Such undesirable plants as star thistle and tarweed are encouraged to grow by late spring rains after the annual grasses and grain have matured.

Hydrology-Drainage Patterns. The county is drained by the Sacramento River on the east. Two major streams, Cache Creek and Putah Creek, cross the county from west to east, but they drain little of the county. The Cottonwood and Willow Sloughs drain the area between Putah Creek and Cache Creek in the southern part of the county. The northern part of the county is drained by intermittent streams, such as Oat Creek and Bird Creek, which drain into the Colusa Basin Drainage Canal. When the Sacramento River reaches a specific height, it flows into the Yolo Bypass that extends along the eastern side of the county from about 4 miles southeast of the town of Knights Landing to the southernmost part of the county. The area in the southeastern part of the county (between the Yolo Bypass and the Sacramento River) is mostly drained by pumping.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Yolo County include tomatoes, alfalfa, winegrapes, almonds, and seed crops.

Yolo County is intensively cultivated and used mainly for irrigated row crops, field crops, and orchards. In a few small areas, remnants of native vegetation remain. Dryland grain is grown in some areas that are irrigable but do not have an adequate supply of irrigation water. The rolling terraces are used for dryland grain and for pasture of annual grass. The mountainous uplands have a cover mainly of annual grasses and oaks, but brush grows on large areas of the very shallow soils.

Soils. Yolo County is partly in the hilly to steep, mountainous uplands of the California Coast Ranges and partly in the Sacramento Valley. The western part of the county is in the Coast Ranges and consists of parallel ridges and valleys that trend slightly west of north. The streams follow the strike valleys for considerable distances and then cut eastward across the ridges through narrow gaps. The soils are moderately deep to very shallow, though much of the area is bare. The soils in this part of the county are used principally for range; the less productive areas are used as wildlife habitat and for watershed. Gently sloping to hilly dissected terraces occupy the area to the east of the Coast Ranges. This area consists of well-rounded hills and broad slopes that drain to the east. The soils are moderately deep to softly consolidated material or are shallow to a claypan. They are used for dryland small grains and pasture. About two-thirds of the county is in the Sacramento Valley between the Coast Ranges and the Sacramento River. The nearly level soils here are irrigable, though a few areas are not now irrigated. The soils are used for many irrigated crops, orchards, and dryland crops.

YUBA COUNTY GENERAL SUBWATERSHED CHARACTERISTICS

Geography. Yuba County is 640 square miles and is bounded by the Feather River on the west, the Bear River on the south, and Huncut Creek on the north. The eastern boundary is not defined by natural features, but runs from Camp Far West Lake to Smartville, and then follows the South Yuba River past SR-49 before turning northwards.

Yuba County is physically diverse and is composed of three general physiographic regions: the valley, foothills, and mountains. County elevation ranges from about 30 feet above sea level along the Feather River to more than 4,800 feet above sea level in the northeastern corner of the County.

Yuba County incorporated cities include Marysville and Wheatland. Major unincorporated communities include Linda and Olivehurst on the valley floor and Loma Rica/ Browns Valley, Brownsville/Challenge, Oregon House/ Dobbins, Log Cabin, Rackerby, Camptonville, and Smartville in the foothill and mountain regions.

Climate. The average rainfall is 22 inches. The average high is 75° F with an average low of 50° F.

Hydrology-Drainage Patterns. Yuba County's landscape varies from the Feather River valley to the west upward through the rolling foothills region in the central part of the county, into the Sierra Nevada in the eastern third of the county. Elevation in the county ranges from about 30 feet above mean sea level along the Feather River to approximately 4,800 feet above sea level in the northeastern corner of the county.

Major rivers and streams include the Feather River along the western boundary of the county, the Bear River along the southern boundary of the county, South Huncut Creek along the northern boundary of the county, and the Yuba River, which flows westward across the central portion of the county, joining the Feather River at Marysville.

Land Use/Crop Types. According to the 2006 Agricultural Commissioner's Report, the top five crops of value in Yuba County include prunes, rice, walnuts, cling peaches and milk.

Approximately one-quarter of Yuba County is cropland mostly along the Feather and Bear Rivers. Crops include areas used for the cultivation of peaches, prunes, pears, almonds, walnuts, olives, grapes, kiwis, mixed orchards, rice (including hunting uses), row crops, and irrigated and non-irrigated field crops. There are also large areas of forest land located in the eastern one-third of the County. Grazing covers approximately 17% of the total acreage. Grazing lands are concentrated in two belts, one running from Loma Rica to Camp Far West, and the other running between Stanfield Hill and Oregon House.

Soils. NRCS provides soils surveys and reports for Yuba County.

Soils on Floodplains and Terraces (Approximately 42% of the County's Area)

Columbia-Holillipah-Shanghai. These soils are very deep, somewhat poorly drained or somewhat excessively drained alluvial soils on floodplains. The Columbia-Holillipah-Shanghai soils are used for irrigated orchard crops, including peaches, walnuts, prunes, pears, and almonds. These soils are subject to flooding without levee protection. Where these soils are protected from flooding, they include a seasonal high water table or a low available water capacity.

Dumps and Mine Tailings. These soils are very deep material dredged from river channels and floodplains during gold mining, and are located on floodplains. This unit is primarily used as a source of construction material.

Conejo-Kilaga. These soils are deep to very deep, well-drained alluvial soils on stream terraces. The Conejo-Kilaga soils are used for irrigated orchard crops (prunes, walnuts, and almonds). These soils have few limitations, although some areas have a hazard of flooding.

San Joaquin. These soils, found on low fan terraces, are moderately well-drained, alluvial soils that are moderately deep to a hardpan. They have dense clay subsoil. San Joaquin soils are used for irrigated crops – mainly rice and corn. These soils are limited by very slow permeability and a restricted rooting depth.

Redding-Corning-Pardee. These soils are moderately deep, very deep, or shallow. They are well-drained, alluvial soils with dense clay subsoil (or are underlain by bedrock). The unit is located on high fan terraces and hills. Redding-Corning-Pardee soils are used primarily for livestock grazing or urban development. The soils are limited by very slow permeability and/or a very low available water capacity and a restricted rooting depth.

Soils on Foothills and Mountains (Approximately 29% of the County's Area)
Sobrante-Auburn. These soils are moderately deep or shallow and well-drained. They formed in material weathered from basic metavolcanic rocks, found on foothills. The unit is used for livestock grazing, woodland, and homesites. It is limited by a restricted soil depth, slope, and the hazard of water erosion.

Flanly-Mildred. These soils are moderately deep, well drained, and formed in a material weathered from acid and basic intrusive igneous rocks on foothills and mountains. The unit is used for livestock grazing, woodland, and homesites. The soils are limited by the slope, very slow permeability, hazard of water erosion, and restricted rooting depth.

Soils on Mountains (Approximately 29% of the County's Area)
Sites-Surnuf. These soils are well drained and deep or very deep. They formed in material weathered from metamorphic and basic intrusive igneous rocks. The unit is used for timber production and homesites. It is limited by slope and the hazard of water erosion.

Hoda-Hotaw-Holland. These soils are well drained and moderately deep or very deep. They formed in material weathered from acid intrusive igneous rocks. The unit is used mainly for timber production. It is limited by the slope, the hazard of water erosion, and a restricted rooting depth.

Butte-Yuba-Sutter MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and rationale

This subwatershed is moderately heterogeneous in the crops grown and the general geology and topography. Four sites were selected to represent the crops and cultural practices in the Butte-Yuba-Sutter subwatershed.

- Sacramento Slough (in the Lower Feather River drainage) was selected because this drainage represents all of the dominant crops grown in the subwatershed, has a high percentage of irrigated acreage, and is an integrator site for upstream drainage. Monitoring at this site has been coordinated with the California Rice Commission. There has already been extensive monitoring at this site that will help to provide a robust baseline data set. This site represents the southern drainages of the subwatershed.
- Pine Creek at Nord Gianella Road (in Pine Creek drainage) was selected to represent the drainages in the northwest region of the subwatershed. This drainage includes the dominant crops in this region and has had year-round flows in sampling conducted to date.
- Lower Honcut Creek (in Lower Honcut Creek drainage) was selected to represent the drainages in the eastern part of the subwatershed. This drainage includes the dominant crops and typically has flows allowing sampling through irrigation season.
- Lower Snake R. at Nuestro Rd was selected to represent the drainages in the central region of the subwatershed. This drainage includes the dominant crops and has had year-round flows in sampling conducted to date.

In some cases, specific crops that are not widely grown within a region may not be adequately characterized by the representative drainage. In these cases, these specific crops and associated practices may be represented by the monitored representative drainage for another region in the subwatershed.

Monitoring Completed

For developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for all categories of MRP constituents by the end 2008 monitoring.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Butte Slough at Pass Road	8				*8[1]*
	Gilsizer Slough at George Washington Road		7			*7*
	Lower Snake R. at Nuestro Rd			8	8	*16 (8)[2]*
	Pine Creek at Nord Gianella Road	5[3]		5[3]		*10 (5)[1]*
	Sacramento Slough		8	8	8	*24[1]*
	Wadsworth Canal at South Butte Rd	9				*9*
Toxicity, sediment	Butte Slough at Pass Road	2				*2*
	Gilsizer Slough at George Washington Road		2			*2*
	Lower Snake R. at Nuestro Rd			2	2	*4*
	Pine Creek at Nord Gianella Road	1[3]		2		*3*
	Sacramento Slough				2	*2*
	Wadsworth Canal at South Butte Rd	1				*1*
Physical	Butte Slough at Pass Road	7	7			*14*
	Gilsizer Slough at George Washington Road		7	7		*14*
	Lower Snake R. at Nuestro Rd			7	8	*15*
	Pine Creek at Nord Gianella Road	5[3]	4[3]	4[3]		*13*
	Sacramento Slough		9	9	8	*26*
	Wadsworth Canal at South Butte Rd	8	7			*15*
Pathogen Indicator (E. coli)	Butte Slough at Pass Road	6				*6*
	Gilsizer Slough at George Washington Road		7	8		*15*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road	4[3]	4[3]	4[3]		*12*
	Sacramento Slough		9	9	8	*26*
	Wadsworth Canal at South Butte Rd	7	7	2		*16*
Trace Metals	Butte Slough at Pass Road		7			*7*
	Gilsizer Slough at George Washington Road			8		*8*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road		4[3]			*4*
	Sacramento Slough				8	*8*
	Wadsworth Canal at South Butte Rd		7			*7*
Organophosphorus Pesticides	Butte Slough at Pass Road	8	8			*16*
	Gilsizer Slough at George Washington Road		7	8		*15*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road	5[3]	4[3]	4[3]		*13*
	Sacramento Slough		8	8	8	*26*
	Wadsworth Canal at South Butte Rd	8	9			*17*
Carbamates and Urea Herbicides	Butte Slough at Pass Road	4	6			*10*
	Gilsizer Slough at George Washington Road			8		*8*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road	2[3]	4[3]	2[3]		*8*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Sacramento Slough		4	8	8	*20*
	Wadsworth Canal at South Butte Rd	5	6			*11*
Glyphosate	Butte Slough at Pass Road		6			*6*
	Gilsizer Slough at George Washington Road			8		*8*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road		4[3]			*4*
	Sacramento Slough				8	*8*
	Wadsworth Canal at South Butte Rd		6			*6*
Paraquat	Butte Slough at Pass Road		6			*6*
	Gilsizer Slough at George Washington Road			7		*7*
	Lower Snake R. at Nuestro Rd			7	8	*15*
	Pine Creek at Nord Gianella Road		3[3]			*3*
	Sacramento Slough				8	*8*
	Wadsworth Canal at South Butte Rd		6			*6*
Triazine Herbicides	Butte Slough at Pass Road		8			*8*
	Gilsizer Slough at George Washington Road			8		*8*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road		4[3]			*4*
	Sacramento Slough		1	8	8	*17*
	Wadsworth Canal at South Butte Rd		9			*9*
Organochlorine Pesticides	Butte Slough at Pass Road		8			*8*
	Gilsizer Slough at George Washington Road		1	8		*9*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road		4[3]			*4*
	Sacramento Slough		8		8	*16*
	Wadsworth Canal at South Butte Rd		9			*9*
Nutrients	Butte Slough at Pass Road		7			*7*
	Gilsizer Slough at George Washington Road		1	8		*9*
	Lower Snake R. at Nuestro Rd			8	8	*16*
	Pine Creek at Nord Gianella Road		4[3]	4[3]		*8*
	Sacramento Slough		9	9	8	*26*
	Wadsworth Canal at South Butte Rd		7			*7*

1 Additional testing has been performed for CRC ILRP monitoring.
2 Fathead minnow toxicity was not monitored in 2007. Total for fathead tests are in parentheses.
3 Lower sample numbers are due to lack of dry season flows at this site.

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Lower Snake R. at Nuestro Rd	39.1853N, 121.7036W	LSNKR	Core	Core	Assessment
Sacramento Slough bridge near Karnak	38.7850N, 121.6533W	SSKNK	Core & SP[1]	Core[2]	Assessment[2]
Lower Honcut Creek at Hwy 70	39.30915N, 121.59542W	LHNCT	Assessment	Core	Core

Pine Creek at Nord Gianella Road	39.7811N, 121.9877W	PNCGR	Core	Core	Assessment
Gilsizer Slough at George Washington Road	39.0090N, 121.6716W	GILSL	SP[1]	TBD[2]	TBD[2]
Butte Slough at Pass Road	39.1873N, 121.90847W	BTTSL	SP[1]	TBD[2]	TBD[2]
Wadsworth Canal at South Butte Rd	39.1534N, 121.7344W	WADCN	SP[1]	TBD[2]	TBD[2]

1 "SP" indicates Special Project studies or monitoring for management plans
2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Butte-Yuba-Sutter subwatershed for pollutants with known or potential agricultural sources include the following.

- Butte Slough, Wadsworth Canal, Jack Slough, and Lower Bear River are listed for diazinon.
- Lower Feather River (Lake Oroville Dam to Confluence with Sacramento River) is listed for toxicity, chlorpyrifos, and diazinon.
- Lower Feather River is listed for legacy "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene). None of these pesticides is currently registered for agricultural use in California.
- There are no listings for nutrients, salinity, or pathogens.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicates a need for monitoring additional sites. Monitoring for legacy organochlorine pesticides will be supplemented with to address the listing for "Group A Pesticides". Monitoring for chlorpyrifos, diazinon, and toxicity is already included for the ILRP.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	Registered Pesticides	Toxicity	E. coli	Legacy OC Pesticides	Salinity	DO	pH
Lower Snake R. at Nuestro Rd			X				
Pine Creek at Nord Gianella Road	Chlorpyrifos	Selenastrum	X				
Sacramento Slough bridge near Karnak							
Gilsizer Slough at George Washington Road	Diazinon		X	X	X	X	X
Butte Slough at Pass Road		Selenastrum					
Wadsworth Canal at South Butte Rd			X				

1 Only one exceedance with greater than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Butte Creek Sources to Chico	E	E	E	E [WARM];E [COLD]
Below Chico, including Butte Slough	—	E	E	E [WARM];E [COLD]
Feather River Fish Barrier Dam to Sacramento R.	E	E	E	E [WARM];E [COLD]
Yuba River Englebright Dam to Feather R.	E	E	E	E [WARM];E [COLD]
Bear River	E	E	E	E [WARM];E [COLD]
Sutter Bypass	—	E	E	E [WARM];

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary* *streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations*…". All of the listed water bodies are historically direct tributaries to the Sacramento River, with the exception of Rough and Ready Pumping Plant, which must be pumped over the levee into the river. Some tributaries to the Sacramento River in this subwatershed region that are listed in the Basin Plan (lower Butte Creek, Sutter Bypass) specifically did not receive a MUN beneficial use. Tributaries to these waterbodies and similar water bodies in the same drainages are expected to be support similar uses. Based on these provisions of the Basin Plan and the uses specifically designated for the region, water bodies to be monitored for this MRPP are expected to support or have the potential to support AGR, REC-1, and WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5, but not the MUN use. Smaller tributaries such as Pine Creek that lack flow during dry months of the year are expected to support the WARM aquatic life beneficial use seasonally, but not the COLD aquatic life beneficial use, most monitored agricultural water bodies in this area are not expected to support the COLD freshwater aquatic life use.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Lower Snake R. at Nuestro Rd	—	E	E	WARM
Sacramento Slough bridge near Karnak	—	E	E	WARM
Lower Honcut Creek at Hwy 70	—	E	E	WARM
Pine Creek at Nord Gianella Road	—	seasonal[2]	seasonal[2]	WARM, seasonal[2]
Gilsizer Slough at George Washington Road	—	E	E	WARM
Butte Slough at Pass Road	—	E	E	WARM, COLD
Wadsworth Canal at South Butte Rd	—	E	E	WARM

1 Assigned by default to water bodies without specific designated beneficial uses.
2 This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) are associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Butte-Yuba-Sutter Subwatershed represent nearly the entire range of crops grown in the Sacramento Valley. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Butte-Yuba-Sutter subwatershed. Calendars of farm operations are provided for alfalfa, fruit and nut orchards, irrigated pasture, grains, vegetable row crops, and rice. These crops account for over 95 percent of the irrigated croplands in the Butte-Yuba-Sutter Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the Butte-Yuba-Sutter Subwatershed. The major groups of pesticides that are essential to crop protection and that may affect water quality are insecticides, herbicides, fungicides, and copper compounds.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Aldicarb	2,176
	Carbamates	Carbaryl	831
	Carbamates	Methomyl	12,008
	Herbicides	Diuron	12,770
	Herbicides	Glyphosate	202,673
	Herbicides	Linuron	295
	Herbicides	Paraquat dichloride	46,998
	Herbicides	Simazine	8,884
	Herbicides	Trifluralin	13,902
	Metals	Copper	110,724
	Metals	Zinc	1,470
	Organochlorine	Dicofol	1,426
	Organophosphorus	Azinphos-methyl	1,529
	Organophosphorus	Diazinon	4,014
	Organophosphorus	Dimethoate	4,030
	Organophosphorus	Malathion	4,633
	Organophosphorus	Methamidophos	162
	Organophosphorus	Methidathion	123
	Organophosphorus	Methyl parathion	96
	Organophosphorus	Naled	332
	Organophosphorus	Phosmet	2,837
Water and Sediment	Organophosphorus	Chlorpyrifos	25,606
Sediment	Pyrethroids	Bifenthrin	13,504
	Pyrethroids	Cyfluthrin	2,782
	Pyrethroids	Cypermethrin	37
	Pyrethroids	Esfenvalerate	38,024
	Pyrethroids	Fenpropathrin	624
	Pyrethroids	Lambda-cyhalothrin	36,300
	Pyrethroids	Permethrin	16,632

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Oxamyl
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Organophosphorus	Dichlorvos
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton
	Organophosphorus	Phorate

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Monitoring in 2009 will also include assessment monitoring for one new site not previously monitored for the ILRP. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring site and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes*". See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters

- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in **Table 9**. As discussed in **Section 12** modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and *E. coli*. Fecal coliforms and *E. coli* will be monitored monthly for Assessment and Core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from November – August with *Selenastrum*, and from December – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The November – August period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from September through November.
- These monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and August during Assessment periods.

Carbamates

Most carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. There was no reported use of methiocarb, or oxamyl. Aldicarb and carbofuran were applied to less than 0.1% of the total irrigated acres. Carbaryl and methomyl were the only widely used carbamates. Based on use patterns, sampling from May – September would provide a comprehensive monitoring schedule for carbamates, and would cover >95% of the carbamate applications. Because these pesticides are part of the scan also used to analyze for urea-substituted herbicides (e.g., diuron), carbamates will also be monitored in additional months when their use is extremely low.

Organochlorines

Legacy organochlorine pesticides (including "Group A" pesticides) will be monitored in water samples during the storm season (December through March) during Assessment periods and as required for Special Project monitoring. Additional Assessment monitoring will be done in July – September for Dicofol. The Assessment schedule for monitoring organochlorine pesticides is based on the following.

- The only registered pesticide in this category (Dicofol) was applied to ~0.4% of all irrigated acres. All Dicofol applications occurred during dry season months (July – September) with low potential for runoff from irrigated land.
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored December – February and May – September. This period was selected based on the overall application pattern for the nine organophosphorus pesticides that were widely applied. Organophosphorus pesticides had virtually no reported applications from in October, November and March, and relatively low applications in April. Demeton, disulfoton, and phorate had no reported applications, and methamidophos was applied to less than 0.1% of irrigated acreage. The split monitoring period accounts for ~99% of all applications of organophosphorus pesticides.

Herbicides

Diuron, glyphosate, paraquat, simazine, and trifluralin were all widely used herbicides in this subwatershed.

- Diuron will be monitored from November – May (~90% of applications).
- Glyphosate will be monitored from November – August (~95% of applications).
- Paraquat will be monitored from November – August (~95% of applications).
- Simazine will be monitored from November – May (~92% of applications).
- Trifluralin will be monitored from January – June (93% of applications).

This monitoring schedule accounts for approximately 95% of the total acreage treated with these herbicides and includes the storm season when the potential for runoff is highest. Other MRP herbicides in this category (atrazine, cyanazine, and linuron) had no reported applications in 2006. Because diuron and linuron are part of the scan also used to analyze for carbamates, these urea-substituted herbicides will also be monitored in additional months when their use is expected to be extremely low.

Metals and Metalloids

Copper will be monitored in water samples from December through June. Other trace metals will be monitored during the storm season (December through March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications, with a high percentage of applications on rice crops. This monitoring schedule accounts for ~98% of the total acreage treated with copper and includes the storm season when the potential for runoff is highest. In spite of widespread agricultural use of copper, there have not been any exceedances in the subwatershed.
- Zinc is applied to alfalfa (typically January - April) and sometimes to almonds in dry season, but was applied to less than 0.1% of irrigated acres. Applications during storm season would be captured during the scheduled sampling. The applications in fall to almonds are unlikely to runoff and were applied to less than 0.1% of irrigated acres. This agricultural use of zinc has not resulted in any observed exceedances in the subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations of these metals. There have been no exceedances for any of these trace metals in this subwatershed. Boron and selenium have been determined not to be naturally elevated or to approach concentrations of concern for these metals. Based on this, there is no need for continued monitoring of boron and selenium in this subwatershed.
- Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.
- Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment and Core monitoring from April – December. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. MRP Parameters to be monitored in the Butte-Yuba-Sutter subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment and Core	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	DEC-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	NOV-AUG
Water Flea - *Ceriodaphnia*	Assessment	DEC-SEP
Fathead Minnow - *Pimephales*	Assessment	DEC-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Insufficient Use]
Carbaryl	Assessment	MAY-SEP
Carbofuran	Assessment	None [Insufficient Use]
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	JUL-SEP
Oxamyl	Assessment	None [Not Used]
Organochlorines		
DDD	Assessment and SP	DEC-MAR (Storm Season)
DDE	Assessment and SP	DEC-MAR (Storm Season)
DDT	Assessment and SP	DEC-MAR (Storm Season)
Dicofol	Assessment	JUL-SEP
Dieldrin	Assessment and SP	DEC-MAR (Storm Season)
Endrin	Assessment and SP	DEC-MAR (Storm Season)
Methoxychlor	Assessment and SP	DEC-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	MAY-AUG
Chlorpyrifos	Assessment	MAY-SEP
Diazinon	Assessment	DEC-FEB, MAY
Dichlorvos	Assessment	JUL-SEP
Dimethoate	Assessment	JUN-SEP
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyston)	Assessment	None [Not Used]
Malathion	Assessment	JUN-SEP
Methamidophos	Assessment	None [Insufficient Use]
Methidathion	Assessment	DEC-FEB
Parathion-methyl	Assessment	MAY-SEP
Phorate	Assessment	None [Not Used]

Monitoring Parameters	Monitoring Type	Schedule
Phosmet	Assessment	MAY-AUG
Herbicides		
Atrazine	Assessment	None [Not Used]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	NOV-MAY
Glyphosate	Assessment	NOV-AUG
Linuron	Assessment	None [Insufficient Use]
Paraquat dichloride	Assessment	NOV-AUG
Simazine	Assessment	NOV-MAY
Trifluralin	Assessment	JAN-JUN
Metals		
Arsenic (total)	Assessment	DEC-MAR (Storm Season)
Boron (total)	Assessment	None [not regionally elevated]
Cadmium (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Copper (total and dissolved)	Assessment	DEC-JUN
Lead (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Molybdenum (total)	Assessment	DEC-MAR (Storm Season)
Selenium (total)	Assessment	None [not regionally elevated]
Zinc (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	APR-DEC
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity
Grain Size	Assessment	with sediment toxicity

1 Organochlorine monitoring will be supplemented with "Group A" pesticides: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene.

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

20. COALITION GROUP CONTACT INFORMATION

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Colusa-Glenn MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and rationale

This subwatershed is relatively homogeneous in the crops grown and the general geology and topography. Three sites were selected to represent the crops and cultural practices in the Colusa-Glenn subwatershed.

- Colusa Basin Drain above Knight's Landing (in the Lower Colusa Basin drainage) was selected because this drainage represents all of the dominant crops grown in the subwatershed, has a high percentage of irrigated acreage, and is one of the few waterbodies in the region with year-round flows allowing sampling during irrigation season. Monitoring at this site has been coordinated with the California Rice Commission. This site represents the southern drainages in the lower Colusa County region of the subwatershed.
- Freshwater Creek at Gibson Rd was selected to represent the drainages in the middle part of the subwatershed. This drainage includes the dominant crops and has had year-round flows in sampling conducted to date.
- Walker Creek near 99W and CR33 was selected to represent the drainages in the northern part of the subwatershed in Glenn County. This drainage includes the dominant crops and has had year-round flows in sampling conducted to date. There has already been extensive monitoring in this drainage that will help to provide a robust baseline data set. This site is located upstream from the currently monitored Coalition site at County Road 48 to avoid issues associated with low flow velocities and stagnant conditions.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for all categories of MRP constituents by the end 2008 monitoring.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Butte Creek at Gridley Rd Bridge	5	5			*10*
	Colusa Basin Drain above KL				8	*8*
	Colusa Drain near Maxwell Road	5	7			*12*
	Freshwater Creek at Gibson Rd			9	8	*17*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			9	8	*17*
	Rough and Ready Pumping Plant (RD 108)	9				*9*
	Stone Corral Creek near Maxwell Road	5	6			*11*
	Stony Creek on Hwy 45 near Rd 24	9		3		*12*
	Walker Creek at Co Rd 48			12	8	*20*
Toxicity, sediment	Butte Creek at Gridley Rd Bridge	2	2			4
	Colusa Drain near Maxwell Road	1	2			3
	Freshwater Creek at Gibson Rd			2		2
	Logan Creek at 4 Mile-Excelsior Rd			2		2
	Lurline Creek at 99W			2		2
	Rough and Ready Pumping Plant (RD 108)	2				2
	Stone Corral Creek near Maxwell Road	2	2			4
	Stony Creek on Hwy 45 near Rd 24	2	2			4
	Walker Creek at Co Rd 48			2		2
Physical	Butte Creek at Gridley Rd Bridge	5	6			*11*
	Colusa Drain near Maxwell Road	5	7			*12*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			7	8	*15*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant	8	7			*15*
	Stone Corral Creek near Maxwell Road	5	7			*12*
	Stony Creek on Hwy 45 near Rd 24	8	7			*15*
	Walker Creek at Co Rd 48			8	8	*16*
Pathogen Indicator (E. coli)	Butte Creek at Gridley Rd Bridge	5	6			*11*
	Colusa Drain near Maxwell Road	5	7	2		*14*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant	8	7			*15*
	Stone Corral Creek near Maxwell Road	5	7			*12*
	Stony Creek on Hwy 45 near Rd 24	7				*7*
	Walker Creek at Co Rd 48			8	8	*16*
Trace Metals	Butte Creek at Gridley Rd Bridge		6			*6*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Colusa Drain near Maxwell Road		7			*7*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		7			*7*
	Stone Corral Creek near Maxwell Road		1			*1*
	Stony Creek on Hwy 45 near Rd 24		7			*7*
	Walker Creek at Co Rd 48			8	8	*16*
Organophosphorus Pesticides	Butte Creek at Gridley Rd Bridge	7	6			*13*
	Colusa Drain near Maxwell Road	6	7			*13*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant	9	8			*17*
	Stone Corral Creek near Maxwell Road	5	7			*12*
	Stony Creek on Hwy 45 near Rd 24	9	8	1		*18*
	Stony Creek at 99W			1		*1*
	Stony Creek at County Road P			1		*1*
	Walker Creek at Co Rd 48			8	8	*16*
Carbamates and Urea Herbicides	Colusa Drain near Maxwell Road		2			*2*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant	5	7			*12*
	Stone Corral Creek near Maxwell Road		1			*1*
	Stony Creek on Hwy 45 near Rd 24	5	7			*12*
	Walker Creek at Co Rd 48			8	8	*16*
Glyphosate	Butte Creek at Gridley Rd Bridge		6			*6*
	Colusa Drain near Maxwell Road		7			*7*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		7			*7*
	Stone Corral Creek near Maxwell Road		7			*7*
	Stony Creek on Hwy 45 near Rd 24		7			*7*
	Walker Creek at Co Rd 48			8	8	*16*
Paraquat	Butte Creek at Gridley Rd Bridge		6			*6*
	Colusa Drain near Maxwell Road		6			*6*
	Colusa Basin Drain above KL				8	*8*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		6			*6*
	Stone Corral Creek near Maxwell Road		6			*6*
	Stony Creek on Hwy 45 near Rd 24		6			*6*
	Walker Creek at Co Rd 48			8	8	*16*
Triazine Herbicides	Butte Creek at Gridley Rd Bridge		6			*6*
	Colusa Drain near Maxwell Road		7			*7*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		8			*8*
	Stone Corral Creek near Maxwell Road		7			*7*
	Stony Creek on Hwy 45 near Rd 24		8	1		*9*
	Stony Creek at 99W			1		*1*
	Stony Creek at County Road P			1		*1*
	Walker Creek at Co Rd 48			8	8	*16*
Organochlorine Pesticides	Butte Creek at Gridley Rd Bridge		6			*6*
	Colusa Drain near Maxwell Road		7			*7*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		8			*8*
	Stone Corral Creek near Maxwell Road		7			*7*
	Stony Creek on Hwy 45 near Rd 24		8			*8*
	Walker Creek at Co Rd 48			8	8	*16*
Nutrients	Butte Creek at Gridley Rd Bridge		6			*6*
	Colusa Drain near Maxwell Road		7			*7*
	Colusa Basin Drain above KL				8	*8*
	Freshwater Creek at Gibson Rd			8	8	*16*
	Logan Creek at 4 Mile-Excelsior Rd			8	8	*16*
	Lurline Creek at 99W			8	8	*16*
	Rough and Ready Pumping Plant		6			*6*
	Stone Corral Creek near Maxwell Road		7			*7*
	Stony Creek on Hwy 45 near Rd 24		7			*7*
	Walker Creek at Co Rd 48			8	8	*16*

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Colusa Basin Drain above KL	38.8121N, 121.7741W	COLDR	Core	Core	Assessment
Freshwater Creek at Gibson Rd	39.17475N, 122.22648W	FRSHC	Core & SP[1]	Assessment[2]	Core[2]
Walker Creek near 99W and CR33	39.62423N, 122.19652W	WLKCH	Assessment & SP[1]	Core[2]	Core[2]
Butte Creek at Gridley Rd Bridge	39.3619N, 121.8927W	BUCGR	SP only	TBD[2]	TBD[2]
Logan Creek at 4 Mile-Excelsior Rd	39.36530N, 122.1161W	LGNCR	SP only	TBD[2]	TBD[2]
Lurline Creek at 99W	39.218992N, 122.24619W	LRLNC	SP only	TBD[2]	TBD[2]
Rough and Ready Pumping Plant (RD 108)	38.86209N, 121.7927W	RARPP	SP only	TBD[2]	TBD[2]
Stone Corral Creek near Maxwell Road	39.2751N, 122.1043W	SCCMR	SP only	TBD[2]	TBD[2]
Stony Creek on Hwy 45 near Rd 24	39.71005N, 122.00404W	STYHY	SP only	TBD[2]	TBD[2]

1 "SP" indicates Special Project studies or monitoring for management plans
2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Colusa-Glenn subwatershed for pollutants with known or potential agricultural sources include the following.

- Sacramento River from Red Bluff to Knight's Landing for toxicity of unknown causes.
- Colusa Drain for toxicity of unknown causes
- Colusa Drain for azinphos-methyl, carbofuran, diazinon, malathion, methyl parathion, and molinate
- Colusa Drain for legacy "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene). None of these pesticides are currently registered for agricultural use in California.
- There are no listings for nutrients or salinity,
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicates a need for monitoring additional sites. Monitoring for legacy organochlorine pesticides will be supplemented with to address the listing for "Group A" pesticides. Monitoring for chlorpyrifos, diazinon, and toxicity are already included for the ILRP.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Registered Pesticides	Registered Pesticides	Toxicity	E. coli	Legacy OC Pesticides	Salinity	DO	pH
Freshwater Creek at Gibson Rd		Selenastrum				X	
Walker Creek near 99W and CR33	Chlorpyrifos	Ceriodaphnia				X	
Logan Creek at 4 Mile-Excelsior Rd			X				
Lurline Creek at 99W			X	X			
Rough and Ready Pumping Plant (RD 108)			X	X	X	X	
Stone Corral Creek near Maxwell Road			X		X		
Stony Creek on Hwy 45 near Rd 24		Selenastrum[1]					X

1 Only one exceedance with greater than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Sacramento River from Shasta Dam to Colusa Basin Drain	E	E	E	E
Stony Creek	—	E	E	E [WARM];P [COLD]
East Park Reservoir	—	—	E	E [WARM];P [COLD]
Black Butte Reservoir	—	E	E	E [WARM];P [COLD]
Butte Creek, below Chico	—	E	E	E [WARM];E [COLD]
Colusa Basin Drain	—	E	E	E [WARM];P [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". All of the listed water bodies are historically direct tributaries to the Sacramento River, with the exception of Rough and Ready Pumping Plant, which must be pumped over the levee into the river. Tributaries to the Sacramento River in this subwatershed region that are listed in the Basin Plan (Stony Creek, lower Butte Creek, Colusa Drain) specifically did not receive a MUN beneficial use, and the smaller unlisted tributaries monitored by the Coalition are expected to be similar. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5, but not the MUN use. Smaller tributaries that lack flow during dry months of the year are expected to support the WARM aquatic life beneficial use seasonally, but not the COLD aquatic life beneficial use.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Colusa Basin Drain above KL	—	E	E	E [WARM];P [COLD]
Freshwater Creek at Gibson Rd	—	Seasonal[2]	Seasonal[2]	WARM, seasonal[2]
Walker Creek near 99W and CR33	—	E	E	E [WARM]

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Butte Creek at Gridley Rd Bridge	—	E	E	E [WARM]; E [COLD]
Logan Creek at 4 Mile-Excelsior Rd	—	Seasonal[2]	Seasonal[2]	WARM, seasonal[2]
Lurline Creek at 99W	—	Seasonal[2]	Seasonal[2]	WARM, seasonal[2]
Rough and Ready Pumping Plant	—	E	E	E [WARM]
Stone Corral Creek near Maxwell Road	—	Seasonal[2]	Seasonal[2]	WARM, seasonal[2]
Stony Creek on Hwy 45 near Rd 24	—	E	E	E [WARM]

Assigned by default to water bodies without specific designated beneficial uses.
This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Colusa-Glenn Subwatershed represent nearly the entire range of crops grown in the Sacramento Valley. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Colusa-Glenn subwatershed. Calendars of farm operations are provided for alfalfa, grains, fruit and nut orchards, irrigated pasture, and vegetable row crops. These crops account for over 90 percent of the irrigated croplands in the Colusa-Glenn Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the Colusa-Glenn Subwatershed. Four major groups of pesticides that are essential to crop protection and that may affect water quality are used: insecticides, herbicides, and fungicides, and copper compounds.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Aldicarb	2,176
	Carbamates	Carbaryl	831
	Carbamates	Methomyl	12,008
	Herbicides	Diuron	12,770
	Herbicides	Glyphosate	202,673
	Herbicides	Linuron	295
	Herbicides	Paraquat dichloride	46,998
	Herbicides	Simazine	8,884
	Herbicides	Trifluralin	13,902
	Metals	Copper	110,724

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
	Metals	Zinc	1,470
	Organochlorine	Dicofol	1,426
	Organophosphorus	Azinphos-methyl	1,529
	Organophosphorus	Diazinon	4,014
	Organophosphorus	Dimethoate	4,030
	Organophosphorus	Malathion	4,633
	Organophosphorus	Methamidophos	162
	Organophosphorus	Methidathion	123
	Organophosphorus	Methyl parathion	96
	Organophosphorus	Naled	332
	Organophosphorus	Phosmet	2,837
Water and Sediment	Organophosphorus	Chlorpyrifos	25,606
Sediment	Pyrethroids	Bifenthrin	13,504
	Pyrethroids	Cyfluthrin	2,782
	Pyrethroids	Cypermethrin	37
	Pyrethroids	Esfenvalerate	38,024
	Pyrethroids	Fenpropathrin	624
	Pyrethroids	Lambda-cyhalothrin	36,300
	Pyrethroids	Permethrin	16,632

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Oxamyl
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Organophosphorus	Dichlorvos
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton
	Organophosphorus	Phorate

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin

Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of **irrigation are provided in the** Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring site and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes*". See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment and Core monitoring from April – November. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. As discussed in **Section 12** modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and *E. coli*. Fecal coliforms and *E. coli* will be monitored monthly for Assessment and Core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from November – June with *Selenastrum*, and from January – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from September through December.
- The November – June period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- These monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and August during Assessment periods.

Carbamates

Most carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. There was no reported use of carbofuran, methiocarb, or oxamyl. Carbaryl and methomyl were applied to 0.26% and 0.1% of the total irrigated acres treated with pesticides. Methomyl was the only widely used carbamate and was applied to approximately 1.4% percent of the total acres treated with pesticides. Based on use patterns, sampling from May – September would provide a comprehensive monitoring schedule for carbamates, and would cover ~98% of the methomyl applications specifically. Because these pesticides are part of the scan also used to analyze for urea-substituted herbicides (e.g., diuron), carbamates will also be monitored in additional months when their use is extremely low.

Organochlorines

Legacy organochlorine pesticides will be monitored in water samples during the storm season (December through March) during Assessment periods and as required for Special Project monitoring. The Assessment schedule for monitoring organochlorine pesticides is based on the following.

- There were limited agricultural applications of the only registered pesticide in this category (Dicofol), which was applied to less than 0.25% of the irrigated acreage treated with pesticides, and 0.17% of all irrigated acres (1,426 of 842,517 total irrigated acres). All Dicofol applications occurred during dry season months (July – September)) with low potential for runoff from irrigated land.
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored January through August. This period was selected based on the application pattern for the five organophosphorus pesticides that were widely applied (chlorpyrifos, diazinon, dimethoate, malathion, and phosmet). These five pesticides accounted for 95% of the irrigated acreage treated with organophosphorus pesticides. These five pesticides had virtually no reported applications from October through December, and relatively low applications in September when the risk of runoff is low. Other pesticides in this category were applied to less than 0.2% of the total irrigated acreage, or had no reported applications. The January – August monitoring period accounts for ~95% of all applications of organophosphorus pesticides.

Herbicides

Glyphosate, paraquat, diuron, glyphosate, simazine, and trifluralin were all widely used herbicides in this subwatershed. Glyphosate will be monitored from November – August (~95% of applications). Paraquat will be monitored from October – June (~90% of applications). Diuron will be monitored from September – February (~95% of applications). Simazine will be monitored from October – June (~97% of applications). Trifluralin will be monitored from January – June (100% of applications in 2006). This monitoring schedule accounts for more than 95% of the total acreage treated with these herbicides and includes the storm season when the potential for runoff is highest. Most other pesticides in this category were applied to less than 0.05% of the total irrigated acreage, or had no reported applications. Because diuron and linuron are part of the scan also used to analyze for carbamates, these urea-substituted herbicides will also be monitored in additional months when their use is extremely low.

Metals and Metalloids

Copper will be monitored in water samples from December through June. Other trace metals will be monitored during the storm season (December through March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications, with 93% of applications on rice crops, and the remainder used primarily on walnuts, olives, and onions. This monitoring schedule accounts for ~98% of the total acreage treated with copper and includes the storm season when the potential for runoff is highest. In spite of widespread agricultural use of copper, there have not been any exceedances in the subwatershed.
- Zinc is applied to alfalfa (January - April) and almonds (October), but is applied to less than 0.2% of irrigated acres. Applications during storm season would be captured during the scheduled sampling. The applications in fall to almonds are unlikely to runoff and were applied to less than 0.1% of irrigated acres. This agricultural use of zinc has not resulted in any observed exceedances in the subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations of these metals. There have been no exceedances for any of these trace metals in this subwatershed. Boron and selenium have been determined not to be naturally elevated or to approach concentrations of concern for these metals. Based on this, there is no need for continued monitoring of boron and selenium in this subwatershed.
- Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.
- Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment and Core monitoring from April – November. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. MRP Parameters to be monitored in the Colusa-Glenn subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment and Core	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	DEC-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	NOV-JUN
Water Flea - *Ceriodaphnia*	Assessment	DEC-SEP
Fathead Minnow - *Pimephales*	Assessment	DEC-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Insufficient Use]
Carbaryl	Assessment	None [Insufficient Use]
Carbofuran	Assessment	None [Not Used]
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	MAY-SEP
Oxamyl	Assessment	None [Not Used]
Organochlorines[1]		
DDD	Assessment and SP	DEC-MAR (Storm Season)
DDE	Assessment and SP	DEC-MAR (Storm Season)
DDT	Assessment and SP	DEC-MAR (Storm Season)
Dicofol	Assessment	None [Insufficient Use]
Dieldrin	Assessment and SP	DEC-MAR (Storm Season)
Endrin	Assessment and SP	DEC-MAR (Storm Season)
Methoxychlor	Assessment and SP	DEC-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	None [Insufficient Use]
Chlorpyrifos	Assessment	JAN-SEP
Diazinon	Assessment	JAN-SEP

Monitoring Parameters	Monitoring Type	Schedule
Dichlorvos	Assessment	None [Not Used]
Dimethoate	Assessment	None [Not Used]
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyston)	Assessment	None [Not Used]
Malathion	Assessment	JAN-SEP
Methamidophos	Assessment	None [Not Used]
Methidathion	Assessment	JAN-SEP
Parathion-methyl	Assessment	None [Insufficient Use]
Phorate	Assessment	None [Not Used]
Phosmet	Assessment	JAN-SEP
Herbicides		
Atrazine	Assessment	None [Not Used]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	SEP-FEB
Glyphosate	Assessment	NOV-AUG
Linuron	Assessment	None [Insufficient Use]
Paraquat dichloride	Assessment	OCT-JUN
Simazine	Assessment	OCT-JUN
Trifluralin	Assessment	JAN-JUN
Metals		
Arsenic (total)	Assessment	DEC-MAR (Storm Season)
Boron (total)	Assessment	None [not regionally elevated]
Cadmium (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Copper (total and dissolved)	Assessment	DEC-JUN
Lead (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Molybdenum (total)	Assessment	DEC-MAR (Storm Season)
Selenium (total)	Assessment	None [not regionally elevated]
Zinc (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	APR-NOV
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		

Monitoring Parameters	Monitoring Type	Schedule
TOC	Assessment	with sediment toxicity sampling
Grain Size	Assessment	with sediment toxicity sampling

1 Organochlorine monitoring will be supplemented with "Group A" pesticides: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene.

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP).

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

El Dorado MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

One site was selected to represent the crops and cultural practices in the El Dorado subwatershed. Core and assessment monitoring will be conducted at the site located below irrigated agriculture activities occurring in the North Canyon Creek watershed in the Coloma drainage. This drainage has the highest percentage of irrigated acreage and the most irrigated acres in the subwatershed. The North Canyon Creek also captures approximately 45% of the irrigated agricultural activities occurring in the entire subwatershed. North Canyon Creek characterizes all of the significant crops and is representative of water quality and agricultural activities occurring in the remaining portion of the subwatershed. In addition, assessment level monitoring data (e.g., toxicity, physical, chemical, and microbiological constituents) have been collected at this site from 2004 through 2008 for compliance with the Irrigated Lands Program. This monitoring provides significant baseline data to examine water quality trends across years and seasonally within years for this subwatershed. The Coalition proposes to build upon this database, and use it to guide future monitoring and management practice implementation.

Monitoring Completed

For developing this MRPP, completion of MRPs assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed at the proposed monitoring site for categories of MRP constituents relevant to this subwatershed by the end 2008 monitoring. These categories include physical, microbiological, toxicity in water and sediment, pesticides, trace metals, and nutrients. Monitoring of registered pesticides was included in the approved monitoring plans but did not include MRP carbamates, urea-substituted herbicides, glyphosate, or paraquat due to extremely low use in this subwatershed.

Monitoring sites on all three water bodies have been modified over the course of the Coalition's ILRP monitoring, with two locations monitored on each water body. In each case, the changes in site location were minimal and did not significantly change the representation for the water body.

Consequently, the results for different sites on the three water bodies were consolidated for the evaluation of monitoring completed (Table 1). Monitoring was completed at Coon Hollow Creek this past spring. The monitoring site has been moved back to North Canyon Creek effective, July 2008.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 planned
Toxicity, water	North Canyon Creek	4	4	—	3
	South Canyon Creek[3]	4	—	—	—
	Coon Hollow Creek	—	—	8	4
Toxicity, sediment	North Canyon Creek	1	1	—	3
	South Canyon Creek[3]	1	—	—	—
	Coon Hollow Creek	—	—	2	4
Physical, Microbiological	North Canyon Creek	5	8	3	3
	South Canyon Creek[3]	5	—	—	—
	Coon Hollow Creek	—	—	8	4
Metals	North Canyon Creek			7	3
	South Canyon Creek[3]	—	—	—	—
	Coon Hollow Creek			6	4
Organophosphorus pesticides	North Canyon Creek	3	7	3	3
	South Canyon Creek[3]	5	—	—	—
	Coon Hollow Creek				4
Carbamate pesticides	North Canyon Creek	—	*Not monitored based on low use*		
	South Canyon Creek[3]	4	—	—	—
	Coon Hollow Creek	*Not monitored based on low use*			
Herbicides	North Canyon Creek	—	7[1]	—	—
	South Canyon Creek[3]	—	—	—	—
	Coon Hollow Creek	—	—	1[2]	—
Organochlorine pesticides	North Canyon Creek	—	7	3	3
	South Canyon Creek[3]	—	—	—	—
	Coon Hollow Creek	—	—	6	4
Nutrients	North Canyon Creek	—	7	—	3
	South Canyon Creek[3]	—	—	—	—
	Coon Hollow Creek	—	—	6	4

1 Excludes urea-substituted herbicides, glyphosate, or paraquat due to low use.
2 Monitored in single follow-up sample.
3 South Canyon Creek was not a planned site and was monitored due to sampling error.

Monitoring Sites

Proposed monitoring sites and the schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. El Dorado County Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
North Canyon Creek	38.7604N, 120.7102W	NRTCN	Core + SP[1]	Core[2]	Assessment
Coon Hollow Creek	38.75335N, 120.72404W	COONH	SP[1]	TBD[2]	TBD[2]

1 "SP" indicates Special Project studies or monitoring for management plans
2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d Listed Waterbodies

The Central Valley Water Board has listed water bodies in the Sacramento Valley watershed as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. There are currently no water bodies listed as impaired in the El Dorado subwatershed for pollutants with known or potential agricultural sources, and no 303d listings that indicate a need for monitoring additional sites or parameters.

Sites With Exceedances Requiring Management Plans

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	Toxicity	E. coli	Legacy OC Pesticides
North Canyon Creek	—	X	X
Coon Hollow Creek	*Ceriodaphnia*	X	X

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in the table below.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
South Fork American River				
Source to Placerville	E	—	E	P [WARM], E [COLD]
Placerville to Folsom Lake	E	E	E	E [WARM], E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

The South Fork of the American River near Placerville has beneficial uses explicitly designated in the Basin Plan (MUN, REC1, and COLD and WARM aquatic life habitat). The reach above Placerville does not include agricultural supply (AGR) and lists WARM aquatic habitat as a potential use (Table 4). Other water bodies in the subwatershed do not have beneficial uses explicitly designated in the Basin Plan. North Canyon Creek is a direct tributary of the South Fork of the American River, and Coon Hollow Creek is an indirect tributary through South Canyon Creek and North Canyon Creek. The Basin Plan states that "…*beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations*…" Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in **Table 5**.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
North Canyon Creek	E	E	E	E
Coon Hollow Creek	E	E	E	E

1 Assigned by default to water bodies without specific designated beneficial uses.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) are associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. There is a limited range of crops grown in the El Dorado subwatershed. As discussed previously, the predominant agricultural activities in the subwatershed are associated with grapes, apples, pears, stone fruit, and walnuts. These crops account for nearly all of the irrigated croplands in the subwatershed.

Appendix B (Calendars of Agricultural Activities) documents the cultural activities and practices associated with the predominant crops grown in the subwatershed. The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. The Calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides used in the subwatershed are provided in **Appendix B (Calendars of Agricultural Activities)**. This appendix highlights the major types and timing of pesticides used for crop protection in the subwatershed. Use of agricultural pesticides is limited by the range of crops grown in the El Dorado subwatershed.

Agricultural uses of specific pesticides required for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. The primary chemicals used (based on 2006 data) were azinphos-methyl, diazinon, glyphosate, and copper. Other pesticides were used on a very limited basis and none were applied to more than 2.5% (89 acres) of the total irrigated acres in the subwatershed. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total agricultural acreage treated per month for each pesticide used is provided in **Appendix C (Pesticide Use Information)**. MRP pesticides that were not used are listed in Table 7**.** MRP legacy pesticides with no registered agricultural uses are listed in Table 8.

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Carbaryl	45
	Carbamates	Carbofuran	5
	Herbicides	Atrazine	6
	Herbicides	Diuron	2
	Herbicides	Glyphosate	4137.9
	Herbicides	Paraquat dichloride	30
	Herbicides	Simazine	89
	Herbicides	Trifluralin	2
	Metals	Copper	817.58
	Organophosphorus	Azinphos-methyl	895.5
	Organophosphorus	Diazinon	344
	Organophosphorus	Malathion	12
	Organophosphorus	Phosmet	73
Water and Sediment	Organophosphorus	Chlorpyrifos	24
Sediment	Pyrethroids	Bifenthrin	0.1
	Pyrethroids	Cyfluthrin	1
	Pyrethroids	Esfenvalerate	8
	Pyrethroids	Lambda-cyhalothrin	25

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Methiocarb
	Carbamates	Methomyl
	Carbamates	Oxamyl
	Herbicides	Cyanazine
	Herbicides	Linuron
	Organochlorine	Dicofol
	Organophosphorus	Demeton-s
	Organophosphorus	Dichlorvos
	Organophosphorus	Dimethoate
	Organophosphorus	Disulfoton (Disyston)
	Organophosphorus	Methamidophos
	Organophosphorus	Methidathion
	Organophosphorus	Methyl parathion
	Organophosphorus	Phorate
Sediment	Pyrethroids	Cypermethrin
	Pyrethroids	Fenpropathrin
	Pyrethroids	Permethrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

There is generally no surface irrigation as practiced in the valley regions of the El Dorado subwatershed, with the exception of the limited acres of irrigated pasture scattered throughout the county. Most vineyards are irrigated with drip irrigation systems, with a minority irrigated with sprinkler systems. The majority of irrigated pasture is irrigated with sprinklers.

The southern part of El Dorado County is a major wine grape growing region where irrigation supplies are limited to poor producing wells, and a significant proportion of this vineyard acreage is dry farmed. Grapes grown for wine making are typically irrigated in a deficit mode to improve the quality of the grapes for making wine and encouraging the vine roots to obtain deeper subsurface soil moisture.

Water is in short supply throughout the subwatershed and water purveyors have implemented strict water conservation measures. This practice helps to minimize the probability for runoff of irrigation water. The two main water purveyors in El Dorado County on the western slope are El Dorado Irrigation District and Georgetown Divide Public Utility District. Both districts have water conservation programs, as does the El Dorado County Water Agency that covers the entire county.

Water management practices used in the subwatershed include crop hydration (irrigation), and frost prevention. Salinity management is not required in this subwatershed, and pre-planting irrigation is not a common practice for the majority of the crops grown. Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

12. MONITORING PERIODS

Assessment and Core Monitoring will be conducted monthly from December through August (9 months). Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected in the subwatershed from 2005-2008

The recommended MRP sample frequency is year-round monthly monitoring of all parameters. However, conditions in the El Dorado subwatershed in late summer and early fall (September through November) indicate that sampling is not warranted during this period:

1) There is a general lack of irrigated agricultural activity during this period
2) Low potential for runoff due to low seasonal rainfall, and strict irrigation management and water conservation practices.
3) The only significant pesticide application during this period is of glyphosate (September and October). This pesticide has low aquatic toxicity to the test species. It also has a low potential for runoff due to strict conservation and irrigation management practices in this region, a lack of substantial rainfall, and rapid environmental breakdown of glyphosate.

Consequently, sampling is proposed to begin during in December when seasonal precipitation is likely to result in runoff, and to continue through August. This schedule includes the annual cycle of significant agricultural activity, significant agricultural chemical applications, and higher probabilities for runoff from irrigated acreage.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes"*. See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

All MRP pesticides with significant use in the Subwatershed are monitored for assessment monitoring. Modifications were made to the following parameter categories:

Parameters to be monitored for assessment and core monitoring are indicated in Table 9, along with the planned monthly schedule for each parameter. As discussed in **Section 12** modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for assessment monitoring. In the case of the El Dorado subwatershed, there were no significant agricultural applications of most MRP pesticides. Modifications of the schedule and rationale for specific parameter categories are provided in the following sections.

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and *E. coli*. Fecal coliforms and *E. coli* will be monitored monthly for assessment and core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity will be conducted during Assessment monitoring with all three species from February through August. This schedule for monitoring aquatic toxicity is based on the following.

- This period covers the period of pesticide applications with a significant potential to cause toxicity to the test species.
- There is negligible irrigated agricultural activity from September through January.

Sediment toxicity will be monitored in April and August during Assessment periods.

Carbamates

Carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. Only 50 acres were treated with carbaryl (45 acres) and carbofuran (5 acres) in 2006. There was no reported use of aldicarb, carbofuran, methiocarb, or oxamyl. Carbamates as a group were applied to approximately 0.7% percent of the total acres treated with pesticides. Based on the very limited use of carbamates in El Dorado, this class of pesticides is not proposed to be monitored.

Herbicides

Glyphosate will be monitored from December through August during Assessment monitoring periods. It will be also be monitored during Core monitoring in 2009 because this herbicide has not been monitored previously in this watershed for the MRP. This schedule includes the storm season when the risk for runoff of this soluble pesticide is highest. Most other pesticides in this category were applied to less than 1% of the total irrigated acreage, or had no reported applications. Simazine had slightly higher reported agricultural uses (2.4% of total irrigated acres) but was still applied to a total of only 89 irrigated acres in the entire El Dorado subwatershed, and is therefore not included in assessment monitoring due to low use.

Organochlorines

During Assessment periods, legacy organochlorines will be monitored in water samples during the storm season (December through March). This schedule for monitoring organochlorine pesticides is based on the following. Legacy organochlorine pesticides will also be monitored or studied for Special Projects as required by the Coalition Management Plan currently under development. The schedule for monitoring organochlorine pesticides is based on the following.

- There were no agricultural applications of the only registered pesticide in this category (Dicofol).
- All other MRP organochlorines are legacy pesticides with no registered uses and there are no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosional processes associated with higher flows that typically occur with larger storm season precipitation events. These larger rainfall events typically occur during the storm season (December through March).

Organophosporus Pesticides

Azinphos-methyl and diazinon pesticides will be monitored from February through August during Assessment monitoring periods. This schedule completely includes the period of substantial use of these pesticides (Feb–Aug for diazinon, and May-Aug for azinphos-methyl) and includes the overlapping storm season months when runoff potential is highest.

Azinphos-methyl is scheduled for phase out by the EPA after 2012 and is on a strict timeline for decreasing allowable rates in California. Application rates will be substantially reduced for apples and pears in 2011 and 2012, prior to complete phase out. Based on these decreasing allowed rates and the current trend of implementing alternatives to azinphos (mating disruption and reduced risk insecticides), it is anticipated that there will be little azinphos-methyl used in 2011. If the use of azinphos-methyl becomes negligible prior to assessment monitoring in 2011, the monitoring schedule will be modified to discontinue specific monitoring of this pesticide (if approved by Regional Board ILRP Staff). Ongoing monitoring for organophosphates will continue to provide results for this pesticide, however.

The remaining organophosporus pesticides listed in the MRP were not used or received very limited use in the subwatershed. Chlorpyrifos, malathion, and phosmet were each applied to fewer than 100 acres in the subwatershed in 2006. Although these organophosphorus pesticides are not specifically targeted for monitoring, the analytical method used will also provide results for these three pesticides. There was no reported use of other MRP organophosphorus pesticides (Table 7).

Metals and Metalloids

Trace metals will be monitored in water samples from December through during Assessment monitoring. This schedule for monitoring metals is based on the following.

- Copper was the only trace metals with agricultural applications in this subwatershed. More than 90% of the applications were conducted from December through May.

- The majority of the metals on the MRP parameter list are transported primarily through erosive processes associated with high flows that typically occur with high runoff in this subwatershed.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations of these metals. There have been no exceedances for any of these trace metals in this subwatershed. Boron and selenium have been determined not to be naturally elevated or to approach concentrations of concern for these metals. Based on this, there is no need for continued monitoring of boron and selenium in this subwatershed.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. The absence of exceedances of water quality objectives for MRP trace metals in prior Coalition monitoring in this subwatershed indicates that trace metals are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the period of highest risk of erosional transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.

Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment monitoring only from December – March. This schedule does not include the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**). Due to the crops grown in this area, nutrient concentrations in runoff are expected to be low, with the major contributions from sources other than irrigated agriculture. For instance, grapes grown for wine making are fertilized at restricted rates to improve the wine quality. Nutrient applications typically occur in September and October when runoff potential is very low. Therefore the schedule is focused on is focused on wet season months following the typical application period when higher flows increase the potential for runoff of excess nutrients.

Monitoring conducted to date has not indicated that nutrients are elevated, and there are no known water quality problems due to excess nutrients in receiving waters in this subwatershed. Based on the low application rates, limited periods of application, and low potential for runoff of applied nutrients, monitoring of these compounds during Assessment periods only will provide adequate evaluation and tracking of potential water quality problems due to excess nutrients in agricultural runoff.

Table 9. MRP Parameters to be monitored at North Canyon Creek

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	DEC-AUG
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	DEC-AUG
pH (field measure)	Assessment and Core + SP	DEC-AUG
Electrical Conductivity (field measure)	Assessment and Core	DEC-AUG
Dissolved Oxygen (field measure)	Assessment and Core + SP	DEC-AUG
Temperature (field measure)	Assessment and Core	DEC-AUG
Turbidity	Assessment and Core	DEC-AUG
Total Dissolved Solids	Assessment and Core	DEC-AUG
Total Suspended Solids	Assessment and Core	DEC-AUG
Hardness	Assessment	DEC-MAY, with metals
Total Organic Carbon	Assessment and Core	DEC-AUG
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	FEB-AUG
Water Flea - *Ceriodaphnia*	Assessment	FEB-AUG
Fathead Minnow - *Pimephales*	Assessment	FEB-AUG
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Not Used]
Carbaryl	Assessment	None [Insufficient Use]
Carbofuran	Assessment	None [Insufficient Use]
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	None [Not Used]
Oxamyl	Assessment	None [Not Used]
Organochlorines		
DDD	Assessment and SP	DEC-MAR
DDE	Assessment and SP	DEC-MAR
DDT	Assessment and SP	DEC-MAR
Dicofol	Assessment	None [Not Used]
Dieldrin	Assessment and SP	DEC-MAR
Endrin	Assessment and SP	DEC-MAR
Methoxychlor	Assessment and SP	DEC-MAR
Organophosphorus		
Azinphos-methyl	Assessment	MAY-AUG
Chlorpyrifos	Assessment	None [Insufficient Use]
Diazinon	Assessment	FEB-AUG

Monitoring Parameters	Monitoring Type	Schedule
Dichlorvos	Assessment	None [Not Used]
Dimethoate	Assessment	None [Not Used]
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyton)	Assessment	None [Not Used]
Malathion	Assessment	None [Insufficient Use]
Methamidophos	Assessment	None [Not Used]
Methidathion	Assessment	None [Not Used]
Parathion-methyl	Assessment	None [Not Used]
Phorate	Assessment	None [Not Used]
Phosmet	Assessment	None [Insufficient Use]
Herbicides		
Atrazine	Assessment	None [Insufficient Use]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	None [Insufficient Use]
Glyphosate	Assessment	FEB-NOV
Linuron	Assessment	None [Not Used]
Paraquat dichloride	Assessment	None [Insufficient Use]
Simazine	Assessment	None [Insufficient Use]
Trifluralin	Assessment	None [Insufficient Use]
Metals		
Arsenic (total)	Assessment	DEC-MAY
Boron (total)	Assessment	None [No regional sources]
Cadmium (total and dissolved)	Assessment	DEC-MAY
Copper (total and dissolved)	Assessment	DEC-MAY
Lead (total and dissolved)	Assessment	DEC-MAY
Nickel (total and dissolved)	Assessment	DEC-MAY
Molybdenum (total)	Assessment	DEC-MAY
Selenium (total)	Assessment	None [No regional sources]
Zinc (total and dissolved)	Assessment	DEC-MAY
Nutrients -		
Total Kjeldahl Nitrogen	Assessment Only	DEC-MAR
Nitrate plus Nitrite as Nitrogen	Assessment Only	
Total Ammonia	Assessment Only	
Unionized Ammonia (calculated value)	Assessment Only	
Total Phosphorous (as P)	Assessment Only	
Soluble Orthophosphate	Assessment Only	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		

Monitoring Parameters	Monitoring Type	Schedule
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity
Grain Size	Assessment	with sediment toxicity

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Lake-Napa MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and rationale

This subwatershed is relatively homogeneous in the crops grown and the general geology and topography. Two sites were selected to represent the crops and cultural practices in the Lake-Napa subwatershed.

- Pope Creek upstream from Berryessa Lake (in the Pope Creek drainage) was selected because this drainage represents all of the dominant crops grown and has the highest percentage of irrigated acreage in the Napa region of the subwatershed. This site represents all of drainages in the Napa county region of the subwatershed.
- Middle Creek upstream from Highway 20 (in the Upper Lake drainage) includes the dominant crops for the Lake County drainages, has a relatively high percentage of irrigated acres, and typically has flows allowing sampling during at least part of the irrigation season. This site was selected to represent the Lake County drainages in the subwatershed.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

The frequency of monitoring required in the approved monitoring plan for this watershed was limited to three events per year. The reason for this modification of the MRP monitoring schedule was a relatively low percentage of irrigated acreage in this subwatershed, a limited range of crops grown, and low pesticide use. Monitoring in the Lake-Napa Review of the monitoring results indicates that the requirements for Assessment monitoring have been completed or will be completed for Lake County drainages for all categories of MRP constituents by the end of 2008 monitoring. The required MRP constituents for the Lake County region of the subwatershed include physical, microbiological, toxicity in water and sediment, trace metals, pesticides, and nutrients. Monitoring of carbamates and urea herbicides (e.g., diuron), paraquat, and glyphosate was limited in the approved monitoring plans due to low use in these drainages. Glyphosate will have been monitored for a total of only five events at Lake County sites at the completion of 2008 monitoring, and will be scheduled for supplemental monitoring during 2009 to complete the required Assessment monitoring for this herbicide.

The MRP constituents previously required for the Napa County region of the subwatershed was limited to physical and microbiological parameters. Monitoring of toxicity, registered pesticides, and nutrients in the Napa County drainages was not included in the approved monitoring plans due to extremely low percentage of irrigated acreage and low pesticide use in this portion of subwatershed. Monitoring of MRP trace metals and legacy organochlorine pesticides was not included in the approved monitoring plans due to the absence of 303d listings or known impairments for these compounds in the subwatershed. A focus of monitoring on physical parameters and pathogens is consistent with a lack of know water quality problems identified in this subwatershed. Based on evaluation of 2006 pesticide use reporting data, the 2009 Core monitoring will be supplemented with monitoring to assess risks of impacts from trace metals, glyphosate, and simazine. The 2009 Core monitoring will also be supplemented with monitoring to assess metals and nutrients concentrations because these have not previously been monitored in this region.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Middle Creek			3	3	*6*
	McGaugh Slough	2	2			*4*
Toxicity, sediment	Middle Creek			1	2	3
	McGaugh Slough		1			1
Physical	Capell Creek	3	3	3	3	*11*
	Pope Creek	3	3	3	3	*10*
	Middle Creek			3	3	*6*
	McGaugh Slough	2	2			*4*
Microbiological	Capell Creek	3	3	3	3	*11*
	Pope Creek	3	3	3	3	*10*
	Middle Creek			3	3	*6*
	McGaugh Slough	2	2	1		*5*
Trace Metals	Middle Creek			3	3	*6*
	McGaugh Slough	1	2			*3*
Carbamates and Urea Herbicides	Middle Creek			3		*3*
	McGaugh Slough	1				*1*
Organophosphorus Pesticides	Middle Creek			3	3	*6*
	McGaugh Slough	2	2			*4*
Organochlorine Pesticides	Middle Creek			3	3	*6*
	McGaugh Slough		2			*2*
Glyphosate	Middle Creek			2	3	*5*
Paraquat	Middle Creek			2	3	*5*
Pyrethroid Pesticides	McGaugh Slough	1	2			*3*
Triazine pesticides	Middle Creek			3	3	*6*
	McGaugh Slough		2			*2*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Nutrients	Middle Creek			3	3	*6*
	McGaugh Slough		2			*2*

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Middle Creek u/s from Highway 20	39.1764N, 122.913W	MDLCR	Core(1)	Core	Assessment
McGaugh Slough at Finley Road East	39.0042N, 122.8623W	MGSLU	SP(2)	TBD(3)	TBD(3)
Pope Creek upstream from Lake Berryessa	38.6464N, 122.3642W	PCULB	Core	Core	Assessment
Capell Creek upstream from Lake Berryessa	38.4825N, 122.241W	CCULB	SP(2)	TBD(3)	TBD(3)

1 Core monitoring will be supplemented in 2009 to complete assessment for glyphosate
2 "SP" indicates Special Project studies or monitoring for management plans
3 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Water bodies listed as impaired in the Lake-Napa subwatershed for pollutants with known or potential agricultural sources include the following.

- Cache Creek, Lower (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass) for toxicity of unknown causes
- Clear Lake for nutrients

- There are no listings for pesticides, pathogens, or salinity.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicate a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	E. coli	pH
McGaugh Slough	X	
Capell Creek upstream from Lake Berryessa	X	X

1 Only one exceedance with greater than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Cache Creek Clear Lake	E	E	E	E [WARM];P [COLD]
Clear Lake to Yolo Bypass	E	E	E	E [WARM];P [COLD]
Putah Creek Lake Berryessa	E	E	E	E [WARM];E [COLD]
Lake Berryessa to Yolo Bypass	E	E	E	E [WARM];E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". The listed water bodies in Napa County are direct tributaries to Lake Berryessa. The listed water bodies in Lake County are direct tributaries to Clear Lake. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and WARM and COLD aquatic life beneficial uses at least seasonally, as indicated in Table 5. Smaller tributaries (e.g., Pope Creek and Capell Creek) that lack flow during dry months of the year are expected to support the WARM or COLD aquatic life beneficial uses seasonally.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Middle Creek u/s from Highway 20	E	E	E	E [WARM];P [COLD]
McGaugh Slough at Finley Road East	Seasonal[2]	Seasonal[2]	Seasonal[2]	E [WARM], P [COLD] seasonal[2]
Pope Creek upstream from Lake Berryessa	Seasonal[2]	Seasonal[2]	Seasonal[2]	E [WARM], P [COLD] seasonal[2]
Capell Creek upstream from Lake Berryessa	Seasonal[2]	Seasonal[2]	Seasonal[2]	E [WARM], P [COLD] seasonal[2]

1 Assigned by default to water bodies without specific designated beneficial uses.
2 This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps and tables.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Lake-Napa Subwatershed represent a narrow range of crops grown in the Sacramento Valley. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Lake-Napa subwatershed. Calendars of farm operations are provided for pears, walnuts, grapes, and irrigated pasture in the lake county drainages, and olives and wine vineyards in the Napa County drainages. These crops account for over 90 percent of the irrigated croplands in the Lake-Napa Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major categories of pesticides used for crop protection in the Lake-Napa Subwatershed. The major groups of pesticides that are essential to crop protection and that may affect water quality are insecticides, herbicides, and fungicides.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in **Appendix C**. MRP pesticides that were not used in the watershed are listed in Table 7. MRP Pesticides with no registered agricultural uses are listed in Table 8.

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006 (Lake Co.)	(Napa Co.)
Water	Organophosphorus	Azinphos-methyl	363	—
Water	Carbamates	Carbaryl	20	—
Water	Carbamates	Methomyl	4	—
Water	Herbicides	Diuron	219	20
Water	Herbicides	Glyphosate	7368	2885
Water	Herbicides	Paraquat dichloride	19	—
Water	Herbicides	Simazine	481	190
Water	Metals	Copper	3350	1788
Water	Metals	Zinc	45	262
Water	Organophosphorus	Diazinon	67	—
Water	Organophosphorus	Malathion	103	—
Water	Organophosphorus	Phosmet	23	—
Water and Sediment	Organophosphorus	Chlorpyrifos	551	—
Sediment	Pyrethroids	Esfenvalerate	79	—
Sediment	Pyrethroids	Fenpropathrin	214	—

"—" indicates no applications of this pesticide reported in this part of the subwatershed.

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Oxamyl
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Herbicides	Linuron
	Herbicides	Trifluralin
	Organochlorines	Dicofol
	Organophosphorus	Dichlorvos
	Organophosphorus	Dimethoate
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton
	Organophosphorus	Methamidophos

	Organophosphorus	Methidathion
	Organophosphorus	Methyl parathion
	Organophosphorus	Phorate
Sediment	Pyrethroids	Bifenthrin
	Pyrethroids	Cyfluthrin
	Pyrethroids	Cypermethrin
	Pyrethroids	Lambda-Cyhalothrin
	Pyrethroids	Permethrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of **irrigation are provided in the** Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

Note that drip irrigation systems utilizing deficit irrigation management commonly used in the Napa region of the subwatershed preclude the potential for any irrigation-induced runoff or irrigation-induced soil erosion.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the Lake-Napa Subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Agricultural activities with a significant potential to affect water quality are conducted primarily from December through May in Napa County. Pesticides (almost exclusively herbicides) are applied primarily during the December-May period, which includes the wet season and highest runoff potential. There are negligible applications (primarily glyphosate) from June to November. There is a low percentage of irrigated acreage in the subwatershed (~2.9% of the total drainage) and the limited crops grown (primarily wine grapes and olives) typically use very restricted and controlled irrigation practices which nearly eliminate limit runoff potential during irrigation season. In most years, the only two streams with significant contributing irrigated acreage are dry by June. All of these factors combined result in a very low risk of agricultural impacts during most of the irrigation season. Based on these factors, Assessment and Core monitoring will be conducted from December through May in the Napa County portion of the subwatershed. This period covers the great majority of agricultural activities and pesticide applications, and includes the storm season period of higher runoff potential. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring as required for Management Plans.

Agricultural activities with a significant potential to affect water quality are conducted primarily from December through May in Lake County. Pesticides are applied primarily during from January-July, which includes the wet season months with the highest runoff potential, with some late irrigation season applications of insecticides in August and September. There are negligible pesticide applications from October to December. Based on these factors, Assessment and Core monitoring will be conducted monthly from January through September. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring as required for Management Plans. Core monitoring in Napa 2009 will be supplemented with sampling for trace metals.

Assessment Monitoring will next be conducted in 2011. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring site and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes"*. See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for Assessment and Core monitoring are indicated in Table 9. As discussed in **Section 12**, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. Based on the low percentage of irrigated agriculture, limited range of crops, and very low pesticide use, toxicity and most pesticides will not be monitored in the Napa County portion of the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

- **Hardness.** Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and *E. coli*. Fecal coliforms and *E. coli* will be monitored monthly for Assessment and Core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Because of the limited irrigated acreage, low pesticide use, and low potential for agricultural impacts, toxicity will not be monitored in the Napa drainages. If pesticide applications are determined to increase in the subwatershed, or if other practices with increased potential for impacts are implemented, appropriate toxicity monitoring will be initiated during the next Assessment monitoring period.

In Lake County, water column toxicity testing will be conducted monthly during Assessment monitoring from February – May with *Selenastrum*, and from May – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The February – May period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- These toxicity monitoring periods include the months with the greatest potential for runoff of herbicides due to storm events in this subwatershed (February – March).
- The May – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from October through December.

Sediment toxicity will be monitored in Lake County with *Hyalella* in April and August during Assessment periods.

Carbamates

Carbamate pesticides listed in the MRP were not used or received very limited use in this subwatershed. There was no reported use of aldicarb, carbofuran, methiocarb, or oxamyl. Carbaryl and methomyl were applied in Lake County to 0.07% and 0.01% of the total irrigated acres. There was no reported use of carbamates in the Napa County drainages. Based on the lack of carbamate use, there is no need to monitor these pesticides in this subwatershed.

Organochlorines

Legacy organochlorine pesticides will not be monitored in Napa County, due to low agricultural acreage and therefore low historical use in this part of the subwatershed.

Legacy organochlorine pesticides will be monitored in Lake County in water samples from January through March during the storm season for Assessment periods. The Assessment schedule for monitoring organochlorine pesticides in Lake County is based on the following.

- There were no agricultural applications of the only registered pesticide in this category (Dicofol).
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will not be monitored in Napa County because there was no reported use in this part of the subwatershed.

Organophosphorus pesticides will be monitored in Lake County from January-February and May-September. This period was selected based on the application pattern for the three organophosphorus pesticides with significant use (azinphos-methyl, chlorpyrifos, and malathion). These pesticides accounted for more than 90% of the irrigated acreage treated with organophosphorus pesticides. These three pesticides had virtually no reported applications from March and April and from October through December. Other applied pesticides in this category (diazinon and phosmet) were applied to 0.2% and 0.1% of the total irrigated acreage and applications occurred during irrigation season with low risk of runoff. This monitoring period accounts for 100% of the reported applications of organophosphorus pesticides in the Lake County part of the subwatershed in 2006.

Herbicides

Diuron, glyphosate, and simazine were the only herbicides with significant applications in this subwatershed. Diuron will be monitored from February – May in Lake county (~92% of applications). Glyphosate will be monitored from February – July in Lake county (~90% of applications), and from December – May in Napa county (~77% of applications). Simazine will be monitored from February – May in Lake County (>95% of applications), and from December – March in Napa county (100% of 2006 applications). This monitoring schedule accounts for approximately 90% and 78% of the total acreage treated with herbicides in Lake County and Napa County, respectively, and includes the months during storm season when the potential for runoff is highest. Most other pesticides in this category were applied to less than 0.1% of the total irrigated acreage, or were applied to less than 100 acres, or had no reported applications at all. The 2009 Core monitoring in the Napa drainages will be supplemented with herbicides because they were not previously monitored.

Metals and Metalloids

Copper will be monitored in water samples from December – May in Lake County and from January through May in Napa County. Other trace metals will be monitored during storm season, December – March in Lake County and from January –March in Napa County. Because metals have not previously been monitored in the Napa drainages, the 2009 Core monitoring will be supplemented to complete Assessment of trace metals. This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications. This monitoring schedule accounts for >93% of the total acreage treated with copper in Lake County and >95% and of the total acreage treated with copper in Napa County. These monitoring periods include the storm season months when the potential for runoff is highest. There have not been any copper exceedances observed in this subwatershed.
- Zinc is applied to some orchard crops in spring, but was applied to less than 0.2% of irrigated acres in Lake County. Zinc was also applied to approximately 3.4% of irrigated acres in Napa County, but is applied during periods of low runoff risk. The agricultural use of zinc has not resulted in any observed exceedances or water quality concerns in the subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. The absence of exceedances of water quality objectives for MRP trace metals in prior Coalition monitoring in the Lake county portion of the subwatershed indicates that trace metals of concern are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the periods of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.
- Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nutrients will be monitored in Lake County water samples from January – September for Assessment and Core monitoring. This monitoring schedule includes the periods of greatest nutrient use and runoff potential in this region.

Nutrients will be monitored in Napa County water samples from January – May for Assessment monitoring. This more limited monitoring schedule is adequate to characterize risks from runoff of excess nutrients in this region of the subwatershed because of the low percentage of irrigated acreage, the low potential for runoff during most of the year, and the lack of know water quality problems related to excess nutrients. This monitoring includes the periods of nutrient use with significant runoff potential in this region. Although some nutrient applications occur from June through November, these occur during periods when there is little or no rain and therefore little potential for runoff. Streams in the region are typically dry from early summer through November. Because nutrients have not previously been monitored in the Napa drainages, the

2009 Core monitoring will be supplemented to complete Assessement of nutrients. If nutrients are found to be elevated in 2009 monitoring, they will be continued with Core and Assessment monitoring in subsequent years.

Table 9. MRP Parameters to be monitored in the Lake-Napa subwatershed

Monitoring Parameters	Monitoring Type	Lake Schedule	Napa Schedule
Photo Monitoring			
Photograph of monitoring location	Assessment and Core	JAN-SEP	DEC-MAY
WATER COLUMN SAMPLING			
Physical Parameters and General Chemistry			
Flow (field measure)	Assessment and Core	JAN-SEP	DEC-MAY
pH (field measure)	Assessment and Core	JAN-SEP	DEC-MAY
Electrical Conductivity (field measure)	Assessment and Core	JAN-SEP	DEC-MAY
Dissolved Oxygen (field measure)	Assessment and Core	JAN-SEP	DEC-MAY
Temperature (field measure)	Assessment and Core	JAN-SEP	DEC-MAY
Turbidity	Assessment and Core	JAN-SEP	DEC-MAY
Total Dissolved Solids	Assessment and Core	JAN-SEP	DEC-MAY
Total Suspended Solids	Assessment and Core	JAN-SEP	DEC-MAY
Hardness	Assessment and Core	JAN-SEP	DEC-MAY
Total Organic Carbon	Assessment and Core	JAN-SEP	DEC-MAY
Pathogens			
Fecal coliform	Assessment, Core, SP	JAN-SEP	DEC-MAY
E. coli	Assessment, Core, SP	JAN-SEP	DEC-MAY
Water Column Toxicity Test			
Algae -*Selenastrum capricornutum*	Assessment	FEB-MAY	None [Low ag percentage, insufficient pesticide use]
Water Flea - *Ceriodaphnia*	Assessment	MAY-SEP	
Fathead Minnow - *Pimephales*	Assessment	MAY-SEP	
Pesticides			
Carbamates			
Aldicarb	Assessment	None [Not Used]	
Carbaryl	Assessment	None [Insufficient Use]	None [Not Used]
Carbofuran	Assessment	None [Not Used]	
Methiocarb	Assessment	None [Not Used]	
Methomyl	Assessment	None [Insufficient Use]	None [Not Used]
Oxamyl	Assessment	None [Not Used]	
Organochlorines			
DDD	Assessment and SP	JAN-MAR (Storm)	None
DDE	Assessment and SP	JAN-MAR (Storm)	None
DDT	Assessment and SP	JAN-MAR (Storm)	None
Dicofol	Assessment	None [Not Used]	
Dieldrin	Assessment and SP	JAN-MAR (Storm)	None
Endrin	Assessment and SP	JAN-MAR (Storm)	None
Methoxychlor	Assessment and SP	JAN-MAR (Storm)	None

Monitoring Parameters	Monitoring Type	Lake Schedule	Napa Schedule
Organophosphorus			
Azinphos-methyl	Assessment	MAY-JUL	None [Not Used]
Chlorpyrifos	Assessment	JAN-FEB, AUG-SEP	None [Not Used]
Diazinon	Assessment	None [Insufficient Use]	None [Not Used]
Dichlorvos	Assessment	None [Not Used]	
Dimethoate	Assessment	None [Not Used]	
Demeton-s	Assessment	None [Not Used]	
Disulfoton (Disyston)	Assessment	None [Not Used]	
Malathion	Assessment	AUG-SEP	None [Not Used]
Methamidophos	Assessment	None [Not Used]	
Methidathion	Assessment	None [Not Used]	
Parathion-methyl	Assessment	None [Not Used]	
Phorate	Assessment	None [Not Used]	
Phosmet	Assessment	None [Insufficient Use]	None [Not Used]
Herbicides			
Atrazine	Assessment	None [Not Used]	
Cyanazine	Assessment	None [Not Used]	
Diuron	Assessment	FEB-MAY	None [Insufficient Use]
Glyphosate	Assessment	FEB-JUL	DEC-MAY[1]
Linuron	Assessment	None [Not Used]	
Paraquat dichloride	Assessment	None [Insufficient Use]	None [Not Used
Simazine	Assessment	FEB-MAY	DEC-MAR[1]
Trifluralin	Assessment	None [Not Used]	
Metals			
Arsenic (total)	Assessment	DEC-MAR	JAN-MAR[1]
Boron (total)	Assessment	DEC-MAR	JAN-MAR[1]
Cadmium (total and dissolved)	Assessment	DEC-MAR	JAN-MAR[1]
Copper (total and dissolved)	Assessment	DEC-MAY	JAN-MAY[1]
Lead (total and dissolved)	Assessment	DEC-MAR	JAN-MAR[1]
Nickel (total and dissolved)	Assessment	DEC-MAR	JAN-MAR[1]
Molybdenum (total)	Assessment	DEC-MAR	JAN-MAR[1]
Selenium (total)	Assessment	DEC-MAR	JAN-MAR[1]
Zinc (total and dissolved)	Assessment	DEC-MAR	JAN-MAR[1]
Nutrients -			
Total Kjeldahl Nitrogen	Assessment and Core	DEC-APR	JAN-MAY[1] [Assessment Only]
Nitrate plus Nitrite as Nitrogen	Assessment and Core		
Total Ammonia	Assessment and Core		
Unionized Ammonia (calculated)	Assessment and Core		
Total Phosphorous (as P)	Assessment and Core		
Soluble Orthophosphate	Assessment and Core		
SEDIMENT SAMPLING			

Monitoring Parameters	Monitoring Type	Lake Schedule	Napa Schedule
Sediment Toxicity			
Hyalella azteca	Assessment	APR, AUG	None [Insufficient pesticide use]
Pesticides			
Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate Lambda-Cyhalothrin Permethrin Fenpropathrin Chlorpyrifos	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2	None [Not Used]
Other sediment parameters			
TOC	Assessment	with sediment toxicity	NA
Grain Size	Assessment	with sediment toxicity	NA

1 Also supplemented during 2009 Core Monitoring to complete Assessment phase.

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Pit River MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

This subwatershed is heterogeneous in the general geology and topography, but limited and homogeneous in the range of crops grown. Alfalfa, hay, grains, and irrigated pasture are the predominant crops. One site has been selected to represent the crops and cultural practices in the Pit River subwatershed. The drainages represented by each site are also documented in **Appendix A: Subwatershed and Drainage Maps and Drainage Representation**.

- The Pit River at Pittville site (in the Big Lake drainage) was selected to represent drainages in this subwatershed. This drainage includes all the dominant crops of the region and allows year-round sampling. It also serves as an integrator of agricultural runoff for the subwatershed. There has already been extensive monitoring in the drainage that provides a robust baseline data set.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for the representative drainages for all categories of MRP constituents by the end 2008 monitoring. The required MRP constituents for the Pit River subwatershed include physical, microbiological, toxicity in water, and nutrients. Monitoring of registered pesticides was limited in the approved monitoring plans due to extremely low use in this subwatershed. Monitoring of trace metals and legacy organochlorine pesticides was not included in the approved monitoring plans due to the absence of 303d listings or known impairments for these compounds in the subwatershed. The focus of monitoring on physical parameters, pathogens, and nutrients is consistent with the water quality concerns identified in this subwatershed.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Fall River at River Ranch Bridge	3	1	1		*5*
	Pit River at Canby	3	1	1		*5*
	Pit River at Pittville	3	1	1		*5*
Physical Parameters	Fall River at River Ranch Bridge	5	5	6	8	*24*
	Pit River at Canby	5	5	6	8	*24*
	Pit River at Pittville	4	7	6	8	*25*
Pathogen Indicators	Fall River at River Ranch Bridge	5	5	6	8	*24*
	Pit River at Canby	5	5	6	8	*24*
	Pit River at Pittville	4	5	6	8	*23*
Organophosphate Pesticides	Fall River at River Ranch Bridge		2	1		*3*
	Pit River at Canby		2	1		*3*
	Pit River at Pittville		2	1		*3*
Nutrients	Fall River at River Ranch Bridge	5	5	6	8	24
	Pit River at Canby	5	5	6	8	24
	Pit River at Pittville	4	5	6	8	23

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring, and Special Project studies or monitoring for management plans are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Pit River at Pittville	41.0454N, 121.3317W	PRPIT	Core & SP; APR-NOV	Core; APR -NOV	Assessment; APR -NOV
Pit River at Canby Bridge	41.4017N, 120.9310W	PRCAN	SP	TBD	TBD
Fall River at Fall River Ranch Bridge	41.0351N, 121.4864W	FRRRB	SP	TBD	TBD

SP Special Project studies or monitoring for management plans

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?”

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following “pollutant” categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Pit River subwatershed for pollutants with known or potential agricultural sources include the following.

- Pit River for nutrients, organic enrichment/low dissolved oxygen, and temperature.
- Fall River for sedimentation/siltation.
- There are no listings for toxicity, pesticides, trace metals, salinity, or pathogens.

None of these 303d listings indicate a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Registered Pesticides	E. coli	DO	pH
Pit River at Canby Bridge	X	X	
Fall River at Fall River Ranch Bridge			X
Pit River at Pittville		X	X

1 B=Boron; Se=Selenium

2 Only one exceedance with greater than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan for the Pit River and Fall River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Pit River North Fork, South Fork, Pit River	E	E	E	E [WARM];E [COLD]
Confluence of Forks to Hat Creek	E	E	E	E [WARM];E [COLD]
Fall River	E	E	E	E [WARM];E [COLD]
Hat Creek	—	E	E	E [WARM];E [COLD]
Baum Lake	—	—	E	E [COLD]
Mouth of Hat Creek to Shasta Lake	E	E	E	P [WARM];E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

All of the water bodies monitored or proposed to be monitored by the Coalition in this subwatershed have beneficial uses explicitly designated in the Basin Plan. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses, as indicated in Table 5.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Pit River at Canby Bridge	E	E	E	E [WARM];E [COLD]
Fall River at Fall River Ranch Bridge	E	E	E	E [WARM];E [COLD]
Pit River at Pittville	E	E	E	P [WARM];E [COLD]

1 Assigned by default to water bodies without specific designated beneficial uses.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Pit River Subwatershed represent the entire range of crops grown in the Sacramento Valley. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Pit River subwatershed. Calendars of farm operations are provided for alfalfa, fruit and nut orchards, grains, irrigated pasture, and vegetable crops. These crops account for over 90 percent of the irrigated croplands in the Pit River Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the Pit River Subwatershed. Four major groups of pesticides that are essential to crop protection and that may affect water quality are used: insecticides, herbicides, fungicides, and copper compounds.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Carbaryl	16
	Herbicides	Diuron	260
	Herbicides	Glyphosate	128
	Herbicides	Paraquat dichloride	1,358
	Organophosphorus	Malathion	131
	Organophosphorus	Methidathion	280
Sediment	Pyrethroids	Cyfluthrin	309
	Pyrethroids	Permethrin	270
		Total	*2,751*

Table 7. MRP Pesticides with No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Methomyl
	Carbamates	Oxamyl
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Herbicides	Linuron
	Herbicides	Simazine
	Herbicides	Trifluralin
	Organochlorines	Dicofol
	Organophosphorus	Azinphos-methyl
	Organophosphorus	Diazinon
	Organophosphorus	Dichlorvos
	Organophosphorus	Dimethoate
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton
	Organophosphorus	Methamidophos
	Organophosphorus	Methyl parathion
	Organophosphorus	Phorate
	Organophosphorus	Phosmet
Water and Sediment	Organophosphorus	Chlorpyrifos
Sediment	Pyrethroids	Bifenthrin
	Pyrethroids	Cypermethrin
	Pyrethroids	Esfenvalerate
	Pyrethroids	Lambda-Cyhalothrin
	Pyrethroids	Fenpropathrin

Table 8. MRP Legacy Pesticides with No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities are conducted primarily from April through November, and are negligible from December through March, Assessment and Core Monitoring will be conducted monthly from April through November. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring as required for Management Plans. Core monitoring in 2009 willl be supplemented with sampling for trace metals and organochlorine pesticides. Assessment Monitoring will next be conducted in 2011. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns and data for the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring sites and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes"*. See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Table 9**,** with the planned monthly schedule for each parameter. As discussed in **Section 12**, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals (December - June) because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and E. *coli*. Fecal coliforms and E. coli will be monitored monthly during assessment and core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity and Registered Pesticides

Agricultural applications of MRP pesticides are very limited in the range of pesticides applied and in the acreage treated. In 2006, only 2,571 acres of the total 298,000 irrigated acres (<1%) in this subwatershed were treated with MRP pesticides. The majority of these applications were herbicides with a low risk of causing toxicity in surface waters (diuron, glyphosate, and paraquat). MRP pesticides of potential concern for sediment toxicity (pyrethroids) were applied to only 579 acres in 2006, and chlorpyrifos was not applied. Sediment toxicity testing has not been required in previous ILRP monitoring because of the very low pesticide use and low potential for pesticide-cased toxicity in surface waters. No toxicity has been observed in previous Coalition water column toxicity testing in the subwatershed. Based on the pesticide application data and lack of observed toxicity, toxicity and pesticide monitoring in the Pit River watershed is not justified. If pesticide applications are determined to increase significantly in the subwatershed, appropriate monitoring will be initiated during the next Assessment monitoring period.

Organochlorine Pesticides

Organochlorines will be monitored in water samples during the first two monthly events of each Assessment monitoring period (April and May). Because these compounds have not been monitored previously in this subwatershed, they will also be monitored according to this schedule during the first Core monitoring period (2009). This schedule for monitoring organochlorine pesticides is based on the following.

- There were no agricultural applications of the only registered pesticide in this category (Dicofol).

- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- There is very little agricultural activity from November – March in this subwatershed. Tilling and other field preparation activities that can disturb soils and result in sediment runoff are typically not conducted earlier than April when fields become accessible. Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosion processes. Monitoring in April and May will characterize periods when flows are still elevated from spring runoff and the risk of erosion and sediment transport from cultivated acreage is highest.

Metals and Metalloids

Most trace metals will be monitored in water samples from April and May. Boron and selenium will not be monitored in this subwatershed. Because trace metals have not been monitored previously in this subwatershed for the ILRP, they will also be monitored according to this schedule during the first Core monitoring period (2009). This schedule for monitoring metals is based on the following.

- There are no significant agricultural applications of trace metals in the subwatershed.
- The majority of the metals on the MRP parameter list (cadmium, copper, lead, nickel, and zinc) are associated primarily with sediments and transported primarily through erosion associated with higher flows that typically occur from December – May in this region. However, tilling and other field preparation activities that can disturb soils and result in sediment runoff are not typically conducted until April when fields are accessible.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron, molybdenum selenium are more highly soluble trace elements whose transport in surface waters is primarily a result of dissolution from soils. Concentrations in surface water and runoff are determined primarily by their regional geological abundance, and surface water concentrations will be consistently elevated if these elements are regionally abundant. If these trace metals are regionally elevated, this will be apparent from evaluation of only a few samples. Based on the available data, initial monitoring of these trace metals April and May of 2009 is sufficient to evaluate the risk of impacts from regionally elevated metals concentrations. If these trace metals are determined to be elevated regionally, they will continue to be monitored according to the Assessment schedule for trace metals in this subwatershed.
- Hardness will be monitored on the same schedule as trace metals. The only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nutrients will be monitored for Assessment and Core monitoring from April-June and October – November. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (Appendix B: Agricultural Activities Calendar).

Table 9. MRP Parameters to be monitored in the Pit River subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	APR - NOV
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	APR - NOV
pH (field measure)	Assessment and Core	APR - NOV
Electrical Conductivity (field measure)	Assessment and Core	APR - NOV
Dissolved Oxygen (field measure)	Assessment and Core	APR - NOV
Temperature (field measure)	Assessment and Core	APR - NOV
Turbidity	Assessment and Core	APR - NOV
Total Dissolved Solids	Assessment and Core	APR - NOV
Total Suspended Solids	Assessment and Core	APR - NOV
Hardness	Assessment and Core	APR – JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	None, unless changes in pesticide use warrant reassessment
Water Flea - *Ceriodaphnia*	Assessment	
Fathead Minnow - *Pimephales*	Assessment	
Pesticides		
Carbamates		
Aldicarb	Assessment	None [not used]
Carbaryl	Assessment	None [Insufficient Use]
Carbofuran	Assessment	None [not used]
Methiocarb	Assessment	None [not used]
Methomyl	Assessment	None [not used]
Oxamyl	Assessment	None [not used]
Organochlorines		
DDD	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
DDE	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
DDT	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Dicofol	Assessment	None [not used]
Dieldrin	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Endrin	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Methoxychlor	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Organophosphorus		
Azinphos-methyl	Assessment	None [not used]
Chlorpyrifos	Assessment	None [not used]
Diazinon	Assessment	None [not used]
Dichlorvos (Naled breakdown product)	Assessment	None [not used]
Dimethoate	Assessment	None [not used]
Demeton-s	Assessment	None [not used]
Disulfoton (Disyston)	Assessment	None [not used]
Malathion	Assessment	None [Insufficient Use]

Monitoring Parameters	Monitoring Type	Schedule
Methamidophos	Assessment	None [not used]
Methidathion	Assessment	None [Insufficient Use]
Parathion-methyl	Assessment	None [not used]
Phorate	Assessment	None [not used]
Phosmet	Assessment	None [not used]
Herbicides		
Atrazine	Assessment	None [not used]
Cyanazine	Assessment	None [not used]
Diuron	Assessment	None [Insufficient Use]
Glyphosate	Assessment	None [Insufficient Use]
Linuron	Assessment	None [not used]
Paraquat dichloride	Assessment	None [not used]
Simazine	Assessment	None [not used]
Trifluralin	Assessment	None [not used]
Metals		
Arsenic (total)	Core 2009[1]	APR-MAY (Spring Runoff)
Boron (total)	Core 2009[1]	APR-MAY (Spring Runoff)
Cadmium (total and dissolved)	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Copper (total and dissolved)	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Lead (total and dissolved)	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Nickel (total and dissolved)	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Molybdenum (total)	Core 2009[1]	APR-MAY (Spring Runoff)
Selenium (total)	Core 2009[1]	APR-MAY (Spring Runoff)
Zinc (total and dissolved)	Assessment (+ Core 2009)	APR-MAY (Spring Runoff)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	APR-JUN, OCT-NOV
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	None, unless changes in pesticide use warrant reassessment
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity

Monitoring Parameters	Monitoring Type	Schedule
Grain Size	Assessment	with sediment toxicity

1 These trace elements will be continued for future assessment monitoring if they are determined to be elevated.

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

21.

PNSSNS MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the Placer-Nevada-South Sutter-North Sacramento (PNSSNS) subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, agricultural practices and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

This subwatershed is relatively diverse in the crops grown, as well as in the general geology and topography. The subwatershed includes lowland drainages with diverse crops on the valley floor, as well as upland regions and higher elevations with little or no irrigated agriculture. Drainages near the greater Sacramento metropolitan area also include significant urban and residential influences. The potential for confounding factors make the drainages farther from the urban influences more clearly representative of agriculture. One site in the Middle Coon Creek drainage was selected to represent the diversity of crops and cultural practices in the PNSSNS subwatershed. The drainages represented by each site are also documented in **Appendix A: Subwatershed and Drainage Maps and Drainage Representation**.

- Coon Creek at Brewer Road (in the Middle Coon Creek drainage) was selected to represent drainages in this subwatershed. This drainage includes the dominant crops of the region and allows year-round sampling. There has already been extensive monitoring in the drainage that provides a robust baseline data set.

Monitoring Completed

For developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of two storm and six dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for the representative drainages for all categories of MRP constituents by the end 2008 monitoring.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Coon Creek at Brewer Road			8	8	*16 (8)*[1]
	Coon Creek at Striplin Road	8				*8*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, sediment	Coon Creek at Brewer Road			2	2	*4*
	Coon Creek at Striplin Road	2				*2*
Physical Parameters	Coon Creek at Brewer Road			7	8	*15*
	Coon Creek at Striplin Road	8	7			*15*
Pathogen Indicators	Coon Creek at Brewer Road			8	8	*16*
	Coon Creek at Striplin Road	8	7	2		*17*
Trace Metals	Coon Creek at Brewer Road			8	8	*16*
	Coon Creek at Striplin Road		7			*7*
Organophosphate Pesticides	Coon Creek at Brewer Road			10	8	*18*
	Coon Creek at Striplin Road	8	7			*15*
Carbamates and Urea Pesticides	Coon Creek at Brewer Road			8	8	*16*
	Coon Creek at Striplin Road	5	7			*12*
Glyphosate	Coon Creek at Brewer Road			8		*8*
	Coon Creek at Striplin Road		7			*7*
Paraquat	Coon Creek at Brewer Road			7		*7*
	Coon Creek at Striplin Road		6			*6*
Triazine Herbicides	Coon Creek at Brewer Road			12	8	*20*
	Coon Creek at Striplin Road		7			*7*
Legacy Organochlorine Pesticides	Coon Creek at Brewer Road			10	8	*18*
	Coon Creek at Striplin Road		7			*7*
Nutrients	Coon Creek at Brewer Road			8	8	*16*
	Coon Creek at Striplin Road		7			*7*

1 Fathead minnows not monitored in 2007. Totals for fathead minnow tests are in parentheses for affected sites.

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring, and Special Project studies or monitoring for management plans are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Coon Creek at Brewer Road	38.9340N, 121.4518W	CCBRW	Core and SP[1]	Core[2]	Assessment[2]
Coon Creek at Striplin Road	38.8661N, 121.5803W	CCSTR	SP[1]	TBD[2]	TBD[2]

1 “SP” indicates Special Project studies or monitoring for management plans
2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify “known and potential” water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the PNSSNS subwatershed for pollutants with known or potential agricultural sources include the following.

- Natomas East Main Drain for diazinon
- Arcade Creek, Chicken Ranch Slough, and Strong Ranch Slough for chlorpyrifos and diazinon. These urban creek listings are currently being addressed by U.S. EPA approved TMDLs.
- Lower American River (from Nimbus Dam to confluence with Sacramento River) for toxicity of unknown causes.
- There are no listings for nutrients, salinity, or pathogens.
- There are no listings for legacy organochlorine pesticides.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicate a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	Registered Pesticides	E. coli	DO
Coon Creek at Brewer Road		X	
Coon Creek at Striplin Road	Chlorpyrifos	X	X

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Sacramento River, Colusa Drain to I St. Bridge	E	E	E	E [WARM];E [COLD]
American River North Fork, source to Folsom	E	E	E	P [WARM];E [COLD]
Middle fork, source to Folsom	E	E	E	P [WARM];E [COLD]
Folsom Lake	E	E	E	E [WARM];E [COLD]
Folsom Dam to Sacramento R.	E	E	E	E [WARM];E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". The listed water bodies are indirect tributaries to the Sacramento River through the main Canal and the Cross Canal in the Lower Coon Creek drainage. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5. Smaller tributaries in this subwatershed that lack flow during dry months of the year are expected to support the WARM aquatic life beneficial use seasonally, but not the COLD aquatic life beneficial use.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Coon Creek at Brewer Road	E	E	E	E [WARM];E [COLD]
Coon Creek at Striplin Road	E	E	E	E [WARM];E [COLD]

1 Assigned by default to water bodies without specific designated beneficial uses.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, water bodies and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the PNSSNS Subwatershed include most of the types of crops grown in the Sacramento Valley, but are dominated by rice, grains, and pasture. Fruit and nut crops and vegetable row crops are grown, but do not make up a large percentage of the irrigated acreage. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the PNSSNS subwatershed. Calendars of farm operations are provided for alfalfa, fruit and nut orchards, grains, irrigated pasture, vegetable crops, and vineyard. These crops account for over 90 percent of the irrigated non-rice cropland in the PNSSNS Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the PNSSNS Subwatershed. Three major groups of pesticides that are essential to crop protection and that may affect water quality are used: insecticides, herbicides, and fungicides.

Agricultural uses of specific pesticides monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Carbaryl	1,352
	Carbamates	Methiocarb	9
	Carbamates	Methomyl	973
	Herbicides	Atrazine	231
	Herbicides	Diuron	3,491
	Herbicides	Glyphosate	31,733
	Herbicides	Paraquat dichloride	4,973
	Herbicides	Simazine	4,170
	Herbicides	Trifluralin	2,902
	Metals	Copper	40,744
	Metals	Zinc	34
	Organochlorine	Dicofol	605
	Organophosphorus	Azinphos-methyl	467
	Organophosphorus	Diazinon	1,606
	Organophosphorus	Dimethoate	832
	Organophosphorus	Malathion	1,815
	Organophosphorus	Methamidophos	288
	Organophosphorus	Methyl parathion	797
	Organophosphorus	Naled	252
	Organophosphorus	Phorate	162
	Organophosphorus	Phosmet	1,756
Water and Sediment	Organophosphorus	Chlorpyrifos	6,847
Sediment	Pyrethroids	Bifenthrin	857
	Pyrethroids	Cyfluthrin	411
	Pyrethroids	Cypermethrin	402.00
	Pyrethroids	Esfenvalerate	6,697
	Pyrethroids	Fenpropathrin	444
	Pyrethroids	Lambda-cyhalothrin	12,803

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Carbofuran
	Carbamates	Oxamyl
	Herbicides	Cyanazine
	Herbicides	Linuron
	Organophosphorus	Dichlorvos
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton
	Organophosphorus	Methidathion
Sediment	Pyrethroids	Permethrin
	Pyrethroids	Fenpropathrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. The next Assessment monitoring period will be in 2011. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns and data for the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring sites and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes*". See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in **Table 9**. As discussed in Section 12, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness

Hardness will be monitored on the same schedule as trace metals (January -June) because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and E. coli

Fecal coliforms and *E. coli* will be monitored monthly during assessment and core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from December – August with *Selenastrum*, and from January – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The December – August period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).

- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from October through December and little risk of runoff.
- The toxicity monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and August during Assessment periods.

Carbamates

Carbamate pesticides will be monitored June – September. Carbaryl and methomyl were the only MRP carbamates widely used in the subwatershed. There was no reported use of aldicarb, carbofuran, or oxamyl. Methiocarb was applied to less than 0.1% of the total irrigated acres. There have been no detections or exceedances of the MRP carbamates in this subwatershed. Based on these use patterns and monitoring results, there is no need to monitor carbamate pesticides in this subwatershed. Because these pesticides are part of the scan also used to analyze for urea-substituted herbicides (e.g., diuron), carbamate pesticides will still be monitored in additional months when expected use is low.

Organochlorines

Legacy organochlorine pesticides will be monitored in water samples during the storm season (January – March) and from June – September during Assessment periods and as required for Special Project monitoring. The Assessment schedule for monitoring organochlorine pesticides is based on the following.

- Agricultural applications of the only registered pesticide in this category (Dicofol) were conducted from June - September. All dicofol applications occurred during dry season months (June) with low potential for runoff from irrigated land.
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- There have been no detections of legacy organochlorine pesticides in previous ILRP monitoring in this watershed.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored January – February and May – August. This period was selected based on the application pattern for the pesticides that were widely applied, which included most MRP organophosphorus pesticides. These pesticides had very low application rates from September through April, with the exception of diazinon, which had significant applications during January and February. Other pesticides in this category (demeton, disulfoton, and methidathion) were applied to less than 0.1% of the total irrigated acreage and were not detected in subwatershed samples, or had no reported applications. This monitoring period accounts for more than 99% of all applications of organophosphorus pesticides and includes storm season months when the use and risk of runoff of diazinon is highest (January – February).

Herbicides

Diuron, glyphosate, paraquat, simazine, and trifluralin were all widely used herbicides in this subwatershed, and atrazine had some limited use. Cyanazine and linuron were not used in this subwatershed.

- Atrazine will be monitored from May – June (100% of 2006 reported applications).
- Diuron will be monitored from October – May (100% of 2006 reported applications).
- Glyphosate will be monitored from December – September (~95% of applications).
- Paraquat will be monitored from December – August (~92% of applications).
- Simazine will be monitored from October – February (~93% of applications).
- Trifluralin will be monitored from December – September (~98% of applications).

This monitoring schedule accounts for more than 95% of the total acreage treated with these herbicides in 2006 and includes the storm season months when the potential for runoff of pesticides applied during these months is highest. Because diuron and linuron are part of the scan also used to analyze for carbamates, these urea-substituted herbicides will also be monitored in some months when their use is expected to be extremely low. Because simazine and atrazine are part of the same scan used to analyze for triazines, each of these herbicides will also be monitored in some months when their use is expected to be extremely low.

Metals and Metalloids

Copper will be monitored in water samples from January – June. Other trace metals will be monitored during the storm season (January – March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications. This monitoring schedule accounts for ~98% of the total acreage treated with copper and includes the spring months when copper use is highest. There has been one observed copper exceedance in the subwatershed in May 2007.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in storm season months.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations of these metals. There have been no exceedances for any of these trace metals in this subwatershed. Boron and selenium have been determined not to be naturally elevated or to approach concentrations of concern for

these metals. Based on this, there is no need for continued monitoring of boron and selenium in this subwatershed.

The absence of exceedances of water quality objectives for other MRP trace metals in prior Coalition monitoring in indicates that these trace metals are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations. Boron and selenium will be excluded from further Assessment Monitoring. Hardness will be monitored on the same schedule as trace metals. The only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nutrients will be monitored for Assessment and Core monitoring from February – September. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. MRP Parameters to be monitored in the PNSSNS subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment, Core, SP	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	JAN-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	DEC-AUG
Water Flea - *Ceriodaphnia*	Assessment	JAN-SEP
Fathead Minnow - *Pimephales*	Assessment	JAN-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [not used]
Carbaryl	Assessment	JUN-SEP
Carbofuran	Assessment	None [not used]
Methiocarb	Assessment	None [Insufficient use]
Methomyl	Assessment	JUN-SEP

Monitoring Parameters	Monitoring Type	Schedule
Oxamyl	Assessment	None [not used]
Organochlorines		
DDD	Assessment	JAN-MAR (Storm Season)
DDE	Assessment	JAN-MAR (Storm Season)
DDT	Assessment	JAN-MAR (Storm Season)
Dicofol	Assessment	JUN-SEP
Dieldrin	Assessment	JAN-MAR (Storm Season)
Endrin	Assessment	JAN-MAR (Storm Season)
Methoxychlor	Assessment	JAN-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	MAY-AUG
Chlorpyrifos	Assessment and SP	MAY-SEP
Diazinon	Assessment	JAN-FEB, MAY-SEP
Dichlorvos (Naled breakdown product)	Assessment	SEP
Dimethoate	Assessment	JUL-SEP
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyston)	Assessment	None [Not Used]
Malathion	Assessment	JUN-SEP
Methamidophos	Assessment	JUN-AUG
Methidathion	Assessment	None [Not Used]
Parathion-methyl	Assessment	MAY-SEP
Phorate	Assessment	MAY-JUN
Phosmet	Assessment	MAY-AUG
Herbicides		
Atrazine	Assessment	MAY-JUN
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	OCT-MAY
Glyphosate	Assessment	DEC-SEP
Linuron	Assessment	None [Not Used]
Paraquat dichloride	Assessment	DEC-AUG
Simazine	Assessment	OCT-FEB
Trifluralin	Assessment	FEB-JUL
Metals		
Arsenic (total)	Assessment	JAN-MAR (Storm Season)
Boron (total)	Assessment	None [not regionally elevated]
Cadmium (total and dissolved)	Assessment	JAN-MAR (Storm Season)
Copper (total and dissolved)	Assessment	JAN-JUN
Lead (total and dissolved)	Assessment	JAN-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	JAN-MAR (Storm Season)
Molybdenum (total)	Assessment	JAN-MAR (Storm Season)
Selenium (total)	Assessment	None [not regionally elevated]
Zinc (total and dissolved)	Assessment	JAN-MAR (Storm Season)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	FEB-SEP
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		

Monitoring Parameters	Monitoring Type	Schedule
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin Cyfluthrin Cypermethrin Esfenvalerate Lambda-Cyhalothrin Permethrin Fenpropathrin Chlorpyrifos	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Other sediment parameters		
TOC	Assessment	with sediment toxicity
Grain Size	Assessment	with sediment toxicity

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps and Drainage Representation

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Sacramento-Amador MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

The Sacramento-Amador Subwatershed encompasses portions of two counties, Sacramento and Amador. This subwatershed includes two distinct regions: Delta islands in southern Sacramento County and more upland drainages in Amador and southeast Sacramento counties. Two sites were selected to represent the crops and cultural practices in the Sacramento-Amador subwatershed.

- Cosumnes River at Twin Cities Road in the Lower Cosumnes River drainage was selected because this drainage represents all of the dominant crops grown in the Amador and southern Sacramento counties (pasture, vineyards, corn, grain, sudan grass), has a high percentage of irrigated acreage, and has good sampling access and flows for sampling most of the year. The site was also chosen to minimize urban influences and dairy operations that are not part of the ILRP. This site is representative of all the non-Delta drainages in the subwatershed. There has already been two years of ILRP monitoring in the drainage that will help to provide a robust baseline data set.
- Grand Island at Leary Road was selected to represent Delta island drainages. Delta Islands are not This drainage includes the dominant crops grown on Delta islands. One year of ILRP Assessment monitoring will have been completed at this site at the end of 2008.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for all categories of MRP constituents by the end 2008 monitoring in the two representative drainages. Total numbers of irrigation season events were reduced at the Cosumnes River and Dry Creek drainages due to lack of flows at the end of the dry season. The Grand Island site is expected to have a complete set of ILRP Assessment results at the end of the irrigation season 2008. Laguna Creek and Dry Creek are similar sites and together will have more than 2 years of ILRP storm season and irrigation season Assessment monitoring completed.

Table 1. Monitoring Completed in Subwatershed Water Bodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Physical	Big Indian Creek at Bridge	2	1			*3*
	Cosumnes River at Twin Cities Rd	6(1)	6(1)			*12*
	Dry Creek at Alta Mesa Road		7(1)	5(1)		*12*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*
Pathogen Indicator (E. coli)	Big Indian Creek at Bridge	1	1			*2*
	Cosumnes River at Twin Cities Rd	5(1)				*5*
	Dry Creek at Alta Mesa Road		7(1)	5(1)		*12*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*
Trace Metals	Big Indian Creek at Bridge	2	1			*3*
	Cosumnes River at Twin Cities Rd	3(1)	6(1)			*9*
	Dry Creek at Alta Mesa Road			5(1)		*5*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*
Organophosphorus Pesticides	Big Indian Creek at Bridge	1	1			*2*
	Cosumnes River at Twin Cities Rd	6(1)	6(1)			*12*
	Dry Creek at Alta Mesa Road			6(1)		*6*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			9	8	*17*
	Laguna Creek below the Reclamation Canal			1		*1*
Carbamates and Urea Herbicides	Big Indian Creek at Bridge	1	1			*2*
	Cosumnes River at Twin Cities Rd	3(1)	4(1,2)			*7*
	Dry Creek at Alta Mesa Road			6(1)		*6*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*
Organochlorine Pesticides	Big Indian Creek at Bridge	1	1			*2*
	Cosumnes River at Twin Cities Rd	3(1)	6(1)			*9*
	Dry Creek at Alta Mesa Road			7(1)		*7*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*
Glyphosate	Big Indian Creek at Bridge		1			*1*
	Cosumnes River at Twin Cities Rd	2(1)	6(1)			*8*
	Dry Creek at Alta Mesa Road			6(1)		*6*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8		*8*
Paraquat	Big Indian Creek at Bridge					
	Cosumnes River at Twin Cities Rd	2(1)	5(1)			*7*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Dry Creek at Alta Mesa Road			5		*5*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			7		*7*
Triazine Herbicides	Big Indian Creek at Bridge	2	1			*3*
	Cosumnes River at Twin Cities Rd	3(1)	6(1)			*9*
	Dry Creek at Alta Mesa Road			6		*6*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			10	5	*15*
	Laguna Creek below the Reclamation Canal			1		*1*
Nutrients	Big Indian Creek at Bridge	3	1			*4*
	Cosumnes River at Twin Cities Rd	4	6			*10*
	Dry Creek at Alta Mesa Road			5		*5*
	Grand Island Drain near Leary Road				8	*8*
	Laguna Creek at Alta Mesa Rd			8	8	*16*

1 Some irrigation season events not sampled due to lack of flow
2 Carbamates and urea pesticides were sampled in Storm and early irrigation season to coincide with use.

Monitoring Sites

Proposed monitoring sites and the schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Cosumnes River at Twin Cities Rd	38.29098N, 121.38044W	CRTWN	Core & SP	Core	Assessment
Grand Island Drain near Leary Road	38.2399N, 121.5649W	GIDLR	Core & SP	Core	Assessment
Dry Creek at Alta Mesa Road	38.248N, 121.226W	DCGLT	SP only	TBD	TBD
Laguna Creek at Alta Mesa Rd	38.31102N, 121.2263W	LAGAM	SP only	TBD	TBD

SP Special Project studies or monitoring for management plans

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify “known and potential” water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition’s ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: “Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Sacramento-Amador subwatershed for pollutants with known or potential agricultural sources include the following.

- Northern Delta waters for toxicity of unknown causes.
- Northern Delta waters for chlorpyrifos, and diazinon.
- Northern Delta waters for legacy "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene) and DDT. None of these pesticides is currently registered for agricultural use in California.
- There are no listings for pathogens or pathogen indicators.
- There are no listings for nutrients or salinity.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicates a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Monitoring Site	Toxicity	E. coli	Legacy OC Pesticides	Salinity	DO and/or pH
Cosumnes River at Twin Cities Rd	*Hyalella*(1)				X
Grand Island Drain near Leary Road			X	X	
Dry Creek at Alta Mesa Road		X			X
Laguna Creek at Alta Mesa Rd	*Ceriodaphnia*	X			X

1 Two statistical exceedances with less than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Cosumnes River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Cosumnes River from Source to Delta	E	E	E	E [WARM];E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". Laguna Creek and Dry Creek are direct tributaries to the Cosumnes River. Grand Island Drain discharge must be pumped over the levee into the Sacramento River in the Delta, and as a constructed agricultural drain does not automatically receive the designated Beneficial Uses of the Delta. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5. Smaller tributaries that lack flow during dry months of the year are expected to support the WARM aquatic life beneficial use seasonally, but not the COLD aquatic life beneficial use. As a constructed agricultural drain without specifically designated beneficial uses, Grand Island Drain is expected to support the AGR and WARM uses, but not the MUN, REC1, or COLD uses.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Cosumnes River at Twin Cities Rd	E	E	E	E [WARM];E [COLD]
Grand Island Drain near Leary Road	—	E	—	E [WARM]
Dry Creek at Alta Mesa Road	E	E	E	Seasonal[2]
Laguna Creek at Alta Mesa Rd	E	E	E	Seasonal[2]

1 Assigned by default to water bodies without specific designated beneficial uses.
2 This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown in the Sacramento-Amador Subwatershed represent a subset of crops grown in the Sacramento Valley watershed. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Sacramento-Amador subwatershed. Calendars of farm operations are provided for alfalfa, grains, irrigated pasture, field and row crops, wine grapes, apples, cherries, pears, and walnuts. These crops account for over 90 percent of the irrigated croplands in the Sacramento-Amador Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the Sacramento-Amador Subwatershed. Four major groups of pesticides that are essential to crop protection and that may affect water quality are used: insecticides, herbicides, and fungicides, and copper compounds.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Carbaryl	2,355
	Carbamates	Carbofuran	176
	Carbamates	Methiocarb	9
	Carbamates	Methomyl	712
	Herbicides	Atrazine	512
	Herbicides	Diuron	4,346
	Herbicides	Glyphosate	34,872
	Herbicides	Linuron	662
	Herbicides	Paraquat dichloride	4,032
	Herbicides	Simazine	3,868
	Herbicides	Trifluralin	5,139
	Metals	Copper	7,437
	Metals	Zinc	445
	Organophosphorus	Azinphos-methyl	909
	Organophosphorus	Diazinon	474
	Organophosphorus	Dimethoate	1,264
	Organophosphorus	Disulfoton	718
	Organophosphorus	Malathion	119
	Organophosphorus	Methyl parathion	106
	Organophosphorus	Phorate	2,274
	Organophosphorus	Phosmet	2,019
Water and Sediment	Organophosphorus	Chlorpyrifos	824
Sediment	Pyrethroids	Bifenthrin	623
	Pyrethroids	Cyfluthrin	407
	Pyrethroids	Cypermethrin	53
	Pyrethroids	Esfenvalerate	3,956

Pyrethroids	Fenpropathrin	615
Pyrethroids	Lambda-cyhalothrin	5,345
Pyrethroids	Permethrin	275

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Oxamyl
	Herbicides	Cyanazine
	Organochlorines	Dicofol
	Organophosphorus	Dichlorvos
	Organophosphorus	Demeton-s
	Organophosphorus	Methamidophos
	Organophosphorus	Methidathion
Sediment	Pyrethroids	Fenpropathrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring site and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes*". See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS ()

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Table 9. As discussed in **Section 12**, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and E. coli. Fecal coliforms and *E. coli* will be monitored or studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from October – June with *Selenastrum*, and from January – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).

- There is negligible use of insecticides by irrigated agricultural from September through December.
- The October – June period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- These toxicity monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and August during Assessment Monitoring years.

Carbamates

Most carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. There was no reported use of aldicarb or oxamyl. Carbofuran and methiocarb were applied to 0.1% and 0.01% of the total irrigated acres treated with pesticides. Carbaryl was the only widely used carbamate and was applied to approximately 1.3% percent of the total acres treated with pesticides. Based on use patterns, sampling from June – October would provide a comprehensive monitoring schedule for carbamates, and would cover >90% of carbaryl and methomyl applications. Because these pesticides are part of the scan also used to analyze for urea-substituted herbicides (e.g., diuron), carbamates will also be monitored in additional months when their use is extremely low.

Organochlorines

Legacy organochlorine pesticides will be monitored in water samples during the storm season (December through March) during Assessment periods and as required for Special Project monitoring. The Assessment schedule for monitoring organochlorine pesticides is based on the following.

- There were no agricultural applications of the only registered pesticide in this category (Dicofol).
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently, they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored January through October. This period was selected based on the application pattern for the five organophosphorus pesticides that were widely applied (azinphos methyl, chlorpyrifos, dimethoate, phorate, and phosmet) plus diazinon and disulfoton. These pesticides had virtually no reported applications from November through December. Other pesticides in this category were applied to less than 0.1% of the total irrigated acreage, or had no reported applications. The January – October monitoring period accounts for ~95% of all applications of organophosphorus pesticides.

Herbicides

Atrazine, diuron, glyphosate, paraquat, simazine, and trifluralin were all widely used herbicides in this subwatershed. Atrazine will be monitored from April – June (100% of applications in 2006). Diuron will be monitored from November – May (~90% of applications). Glyphosate will be monitored from December – July (~92% of applications). Paraquat will be monitored from December – March and June – August (~91% of applications). Simazine will be monitored from November – April (~88% of applications). Trifluralin will be monitored from January – June (~92% of applications). This monitoring schedule accounts for more than 90% of the total acreage treated with these herbicides and includes the storm season when the potential for runoff is highest. Most other pesticides in this category were applied to less than 0.4% of the total irrigated acreage (linuron), or had no reported applications. Because diuron and linuron are part of the scan also used to analyze for carbamates, these urea-substituted herbicides will be monitored in additional months when their use is extremely low.

Metals and Metalloids

Copper will be monitored in water samples from December through June. Other trace metals will be monitored during the storm season (December through March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications, with virtually all reported applications on rice crops. This monitoring schedule accounts for ~93% of the total acreage treated with copper and includes the storm season when the potential for runoff is highest. There have not been any copper exceedances in the subwatershed.
- Zinc is applied to approximately 0.25% of irrigated acres, with ~66% applied in December. Applications during storm season would be captured during the scheduled sampling. The agricultural use of zinc has not resulted in any observed exceedances in the subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. The absence of exceedances of water quality objectives for MRP trace metals in prior Coalition monitoring in this subwatershed indicates that trace metals are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.
- Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

The majority of nutrient applications in this subwatershed are applied from February – September. Nutrients are sometimes applied to grain crops after this period, but these crops represent only a small percent of the overall cultivated acreage, and grain crops are primarily dry farmed in this subwatershed. Monitoring during this period will adequately characterize excessive runoff of nutrients from irrigated agricultural acreage.

Table 9. MRP Parameters to be monitored in the Sacramento-Amador subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment and Core	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	DEC-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform *E. coli*	Assessment and Core	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	OCT-JUN
Water Flea - *Ceriodaphnia*	Assessment	JAN-SEP
Fathead Minnow - *Pimephales*	Assessment	JAN-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Not Used]
Carbaryl	Assessment	JUN-OCT
Carbofuran	Assessment	None [Insufficient Use]
Methiocarb	Assessment	None [Insufficient Use]
Methomyl	Assessment	JUN-OCT
Oxamyl	Assessment	None [Not Used]
Organochlorines		
DDD	Assessment and SP	DEC-MAR (Storm Season)
DDE	Assessment and SP	DEC-MAR (Storm Season)
DDT	Assessment and SP	DEC-MAR (Storm Season)
Dicofol	Assessment	None [Not Used]
Dieldrin	Assessment and SP	DEC-MAR (Storm Season)
Endrin	Assessment and SP	DEC-MAR (Storm Season)
Methoxychlor	Assessment and SP	DEC-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	MAY-JUL
Chlorpyrifos	Assessment	JAN-APR
Diazinon	Assessment	JAN-MAR, OCT
Dichlorvos	Assessment	None [Naled Not Used]

Monitoring Parameters	Monitoring Type	Schedule
Dimethoate	Assessment	APR, AUG-SEP
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyston)	Assessment	SEP-OCT
Malathion	Assessment	None [Insufficient Use]
Methamidophos	Assessment	None [Not Used]
Methidathion	Assessment	None [Not Used]
Parathion-methyl	Assessment	None [Insufficient Use]
Phorate	Assessment	MAY-JUN
Phosmet	Assessment	MAY-JUL
Herbicides		
Atrazine	Assessment	APR-JUN
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	NOV-MAY
Glyphosate	Assessment	DEC-JUL
Linuron	Assessment	None [Insufficient Use]
Paraquat dichloride	Assessment	DEC-MAR, JUN-AUG
Simazine	Assessment	NOV-APR
Trifluralin	Assessment	JAN-JUN
Metals		
Arsenic (total)	Assessment	DEC-MAR (Storm Season)
Boron (total)	Assessment	DEC-MAR (Storm Season)
Cadmium (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Copper (total and dissolved)	Assessment	DEC-JUN
Lead (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Molybdenum (total)	Assessment	DEC-MAR (Storm Season)
Selenium (total)	Assessment	DEC-MAR (Storm Season)
Zinc (total and dissolved)	Assessment	DEC-JUN
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	FEB-SEP
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		

Monitoring Parameters	Monitoring Type	Schedule
TOC	Assessment	with sediment toxicity sampling
Grain Size	Assessment	with sediment toxicity sampling

QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

COALITION GROUP CONTACT INFORMATION

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Shasta-Tehama MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and rationale

One site was selected to represent the crops and cultural practices in the Shasta-Tehama subwatershed. Anderson Creek at Ash Creek Road (in the Anderson Creek drainage) was selected because this drainage represents all of the dominant crops grown in the subwatershed, has a relatively high percentage of irrigate acreage, and is one of the few streams in the region with year-round flows allowing sampling during irrigation season.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRPs assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Crops and cultural practices are very consistent in drainages with irrigated acreage in this watershed, so monitoring was consolidated for the three drainages sampled to date. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for nearly all categories of MRP constituents by the end 2008 monitoring. The one exception is legacy organochlorine pesticides: Legacy pesticides were not proposed to be monitored in these drainages due to the absence of 303d listings in the subwatershed receiving waters. Consequently, organochlorine pesticides will be monitored in Anderson Creek during the first year of core monitoring according to the schedule described in this MRPP to fulfill this requirement.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 planned
Physical, Microbiological	Anderson Creek at Ash Creek Road	—	7	9	—
	Burch Creek	3 (4 dry)	3 (4 dry)	—	—
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Toxicity, water	Anderson Creek at Ash Creek Road	—	7		—
	Burch Creek	4 (4 dry)	4 (4 dry)	—	—

MRP Monitoring Category	Site	2005	2006	2007	2008 planned
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Toxicity, sediment	Anderson Creek at Ash Creek Road	—	2		—
	Burch Creek	1	—	—	—
	Coyote Creek at Tyler Road	—	—	2	2
Metals	Anderson Creek at Ash Creek Road	—	1	8	—
	Burch Creek	3 (4 dry)	3 (4 dry)	—	—
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Organophosphorus pesticides	Anderson Creek at Ash Creek Road	—	7	8	—
	Burch Creek	3 (4 dry)	3 (4 dry)	—	—
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Carbamate pesticides	Anderson Creek at Ash Creek Road	*Carbamate pesticides were not monitored at these sites due to low use in this watershed*			
	Burch Creek				
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Herbicides	Anderson Creek at Ash Creek Road	*Not monitored at these sites due to low use in this watershed of most herbicides*			
	Burch Creek				
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8
Organochlorine pesticides	Anderson Creek at Ash Creek Road	*Legacy pesticides were not monitored at these sites based on absence of 303d listings in these drainages and receiving waters*			
	Burch Creek				
	Coyote Creek at Tyler Road				
Nutrients	Anderson Creek at Ash Creek Road	—	7	8	—
	Burch Creek	—	3 (4 dry)	—	—
	Coyote Creek at Tyler Road	—	—	4 (4 dry)	8

Monitoring Sites

Proposed monitoring sites and the schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Anderson Creek at Ash Creek Road	40.4180N, 122.2136W	ACACR	Core & SP[1]	Core[2]	Assessment[2]
Burch Creek west of Rawson Rd	39.9254N, 122.2182W	BRCRR	SP[1]	TBD[2]	TBD[2]
Coyote Creek at Tyler Road	40.09261N, 122.15898W	COYTR	SP[1]	TBD[2]	TBD[2]

1 "SP" indicates Special Project studies or monitoring for management plans
2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

- Identification of "known and potential" water quality impairments and water quality limited water bodies.
- Discuss re: MRP Question #1. "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Shasta-Tehama subwatershed for pollutants with known or potential agricultural sources include the following.

- Sacramento River from Keswick to Knight's Landing for toxicity of unknown causes. Monitoring of the mainstem Sacramento River and major tributaries is excluded from the ILRP MRP.
- Cow Creek in Shasta County is listed for fecal coliform.
- There are no listings for pesticides, nutrients, or salinity.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicate a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	E. coli	DO
Anderson Creek at Ash Creek Road	X	X
Burch Creek west of Rawson Rd	X	
Coyote Creek at Tyler Road		X

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Sacramento River from Shasta Dam to Colusa Basin Drain	E	E	E	E
Whiskeytown Reservoir	E	E	E	E
Clear Creek Below Whiskeytown Reservoir	E	E	E	E
Cow Creek	P	E	E	E
Battle Creek		E	E	E
Cottonwood Creek	E	E	E	E
Antelope Creek	E	E	E	E
Mill Creek	E	E	E	E
Thomes Creek		E	E	E
Deer Creek	E	E	E	E

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "…*beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations*…". All of the listed water bodies are direct tributaries to the Sacramento River. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Anderson Creek at Ash Creek Road	E	E	E	E
Burch Creek west of Rawson Rd	Seasonal[2]	Seasonal[2]	Seasonal[2]	Seasonal[2]
Coyote Creek at Tyler Road	Seasonal[2]	Seasonal[2]	Seasonal[2]	Seasonal[2]

1 Assigned by default to water bodies without specific designated beneficial uses.
2 This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Shasta - Tehama Subwatershed are similar to many of the crops grown in other subwatersheds participating in the Sacramento Valley Water Quality Coalition, only the proportion of acreages are different. **Appendix B: Calendars of Agricultural Activities** illustrates the predominant irrigated crops grown in the Shasta – Tehama subwatershed and the other subwatersheds participating in the Sacramento Valley Water Quality Coalition. Calendars of farm operations are provided for walnut, prune, almond, olive, irrigated pasture, and alfalfa. These crops account for over 90 percent of the irrigated croplands in the Shasta - Tehama Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are provided in **Appendix B (Agricultural Practices Calendars).** Appendix B highlights the major categories of pesticides used for crop protection in the Shasta - Tehama Subwatershed. Thee major groups of pesticides that are essential to crop protection and that may affect water quality are used: organophosphorus pesticides (e.g., diazinon and chlorpyrifos), pyrethroids (sediment-associated compounds), and copper compounds.

Agricultural uses of specific pesticides that are required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. **Table 6** lists MRP pesticides used and the total acres treated in 2006. Percentage of total acreage treated per month is also provided for each pesticide in **Appendix C**. MRP pesticides that were not used are listed in **Table 7**. MRP Pesticides with no registered agricultural uses are listed in **Table 8.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Metals	Copper	26158
	Metals	Zinc	30
	Carbamates	Carbaryl	315
	Carbamates	Methomyl	170
	Herbicides	Atrazine	47
	Herbicides	Diuron	3722
	Herbicides	Glyphosate	59291
	Herbicides	Paraquat dichloride	6852
	Herbicides	Simazine	2679
	Herbicides	Trifluralin	383
	Organochlorine	Dicofol	21
	Organophosphorus	Azinphos-methyl	164
	Organophosphorus	Diazinon	2327
	Organophosphorus	Malathion	2669
	Organophosphorus	Methidathion	1609
	Organophosphorus	Methyl parathion	90
	Organophosphorus	Phosmet	1919
Water & Sediment	Organophosphorus	Chlorpyrifos	11051
Sediment	Pyrethroids	Bifenthrin	864
	Pyrethroids	Cyfluthrin	397
	Pyrethroids	Esfenvalerate	9229
	Pyrethroids	Fenpropathrin	6
	Pyrethroids	Lambda-cyhalothrin	294
	Pyrethroids	Permethrin	1032

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Oxamyl
	Organophosphorus	Dichlorvos
	Organophosphorus	Dimethoate
	Organophosphorus	Demeton-s
	Organophosphorus	Disulfoton (Disyton)
	Organophosphorus	Methamidophos
	Organophosphorus	Phorate
	Herbicides	Cyanazine
	Herbicides	Linuron
Sediment	Pyrethroids	Cypermethrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management
- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

The University of California Cooperative Extension (UCCE) conducts problem solving research and demonstration activities and regular outreach activities in the Shasta - Tehama Subwatershed.

Four full-time employees serve the area: One Natural Resource and Livestock Farm Advisor serving the Shasta-Trinity area, and a Natural Resources and Livestock Representative serving Tehama County as well as Glenn and Colusa counties; a Tree Fruit and Nut Crops Farm Advisor in Red Bluff addresses insect and pest management practices that affect surface water quality. and focusing specifically on pest management practices that have low risk to the environment; and a fourth Irrigation and Water Resources Farm Advisor in Red Bluff addresses irrigation management technologies aimed at reducing non-point source transport of pesticides and nutrients on the farm site and with informing grower clientele of the need to be conscientious of water quality concerns and various water quality regulations such as the ILRP.

Conservatively, over twenty field projects and over a dozen outreach events focused on demonstrating and developing BMP's to protect surface water quality and sustain production agriculture are conducted in the Shasta - Tehama Subwatershed annually. Routine communication of new information and knowledge is also provided through local newsletters.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring site and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes"*. See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS ()

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment and Core monitoring from February – October. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. As discussed in **Section 12** modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness. Hardness will be monitored on the same schedule as trace metals because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and *E. coli*. Fecal coliforms and *E. coli* will be monitored monthly for Assessment and Core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from November – August with *Selenastrum*, and from January – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The November – August period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from October through December.
- These monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and late August during Assessment periods.

Carbamates

Carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. There was no reported use of aldicarb, carbofuran, methiocarb, or oxamyl. Carbaryl and methomyl were applied to less than 0.25% of the total irrigated acres, and carbamates as a group were applied to approximately 0.4% percent of the total acres treated with pesticides. Based on the very limited use of carbamates, this class of pesticides is not proposed to be monitored.

Organochlorines

Organochlorines will be monitored in water samples during the storm season (December through March). This schedule for monitoring organochlorine pesticides is based on the following.

- There were extremely limited agricultural applications of the only registered pesticide in this category (Dicofol), which was applied to only 21 acres in 2006 (less than 0.01% of the total irrigated acreage).
- All other MRP organochlorines are legacy pesticides with no registered uses and no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently they are transported primarily through erosional processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored January through September. This period was selected based on the application pattern for the five organophosphorus pesticides that were applied to at least 1% of the total irrigated acreage (chlorpyrifos, diazinon, malathion, methidathion, and phosmet). These five pesticides had virtually no reported applications from October through December. Other pesticides in this category were applied to less than 0.2% of the total irrigated acreage, or had no reported applications.

Herbicides

Glyphosate will be monitored from December through September, and paraquat will be monitored from December through August. This monitoring schedule accounts for more than 95% of the total acreage treated with these herbicides and includes the storm season when the potential for runoff is highest. Most other pesticides in this category were applied to less than 0.3% of the total irrigated acreage, or had no reported applications. Diuron and simazine had slightly higher reported agricultural uses (2.3% and 1.7%, respectively) but were still applied to less than 1% of the total irrigated acres in the entire subwatershed in any month, and are therefore not included in assessment monitoring due to low use.

Metals and Metalloids

Copper will be monitored in water samples from December through June. Other trace metals will be monitored during the storm season (December through March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications. This monitoring schedule accounts for 95% of the total acreage treated with copper and includes the storm season when the potential for runoff is highest. Applications of boron (foliar application to some orchard crops) and molybdenum (to correct for soil deficiencies) have occurred in the Sacramento Valley, but are very rare (Allan Fulton, UCCE, personal communication).
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Arsenic, boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations of these metals. There have been no

exceedances for any of these trace metals in this subwatershed. Boron and selenium have been determined not to be naturally elevated or to approach concentrations of concern for these metals. Based on this, there is no need for continued monitoring of boron and selenium in this subwatershed.

- Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosive transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.
- Hardness will be monitored on the same schedule as trace metals because the primary use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nitrogen and phosphorus compounds will be monitored for Assessment and Core monitoring from February – October. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (**Appendix B: Agricultural Activities Calendar**), and is focused on the dry season when lower flows increase the potential for adverse impacts of excess nutrients in surface waters (stimulation of nuisance algae growth and effects on dissolved oxygen and pH diurnal cycles).

Table 9. MRP Parameters to be monitored at Anderson Creek at Ash Creek Road

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment and Core	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	DEC-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	NOV-AUG
Water Flea - *Ceriodaphnia*	Assessment	JAN-SEP
Fathead Minnow - *Pimephales*	Assessment	JAN-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Not Used]
Carbaryl	Assessment	None [Insufficient Use]
Carbofuran	Assessment	None [Not Used]
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	None [Insufficient Use]
Oxamyl	Assessment	None [Not Used]
Organochlorines		
DDD	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
DDE	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
DDT	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
Dicofol	Assessment (+ Core 2009)	None [Insufficient Use]
Dieldrin	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
Endrin	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
Methoxychlor	Assessment (+ Core 2009)	DEC-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	None [Insufficient Use]
Chlorpyrifos	Assessment	JAN-SEP
Diazinon	Assessment	JAN-SEP
Dichlorvos	Assessment	None [Not Used]
Dimethoate	Assessment	None [Not Used]
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyton)	Assessment	None [Not Used]
Malathion	Assessment	JAN-SEP
Methamidophos	Assessment	None [Not Used]
Methidathion	Assessment	JAN-SEP

Monitoring Parameters	Monitoring Type	Schedule
Parathion-methyl	Assessment	None [Insufficient Use]
Phorate	Assessment	None [Not Used]
Phosmet	Assessment	JAN-SEP
Herbicides		
Atrazine	Assessment	None [Insufficient Use]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	None [Insufficient Use]
Glyphosate	Assessment	DEC-SEP
Linuron	Assessment	None [Not Used]
Paraquat dichloride	Assessment	DEC-AUG
Simazine	Assessment	None [Insufficient Use]
Trifluralin	Assessment	None [Insufficient Use]
Metals		
Arsenic (total)	Assessment	DEC-MAR (Storm Season)
Boron (total)	Assessment	None [not regionally elevated]
Cadmium (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Copper (total and dissolved)	Assessment	DEC-JUN
Lead (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Molybdenum (total)	Assessment	DEC-MAR (Storm Season)
Selenium (total)	Assessment	None [not regionally elevated]
Zinc (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	FEB-OCT
Nitrate plus Nitrite as Nitrogen	Assessment and Core	FEB-OCT
Total Ammonia	Assessment and Core	FEB-OCT
Unionized Ammonia (calculated value)	Assessment and Core	FEB-OCT
Total Phosphorous (as P)	Assessment and Core	FEB-OCT
Soluble Orthophosphate	Assessment and Core	FEB-OCT
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, Late AUG
Pesticides		
Bifenthrin		
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity
Grain Size	Assessment	with sediment toxicity

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

20. COALITION GROUP CONTACT INFORMATION

Inquiries regarding the Sacramento Valley Water Quality Coalition MRPP should be directed to:

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Appendix A. Subwatershed and Drainage Maps and Drainage Representation

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

Solano-Yolo MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

This subwatershed is relatively diverse in the crops grown, as well as in the general geology and topography. The subwatershed includes lowland drainages near and in the Delta, as well as upland regions in the Cache Creek and Putah Creek watersheds. Three sites were selected to represent the diversity of crops and cultural practices in the Solano-Yolo subwatershed. The drainages represented by each site are also documented in **Appendix A: Subwatershed and Drainage Maps and Drainage Representation**.

- Shag Slough at Liberty Island Bridge (in the South Yolo Bypass drainage) was selected to represent drainages in southwestern Solano County and western Yolo County (including Yolo Bypass), and also serves as an integrator of agricultural runoff for the much of the subwatershed. This drainage includes all the dominant crops of the region and allows year-round sampling. There has already been extensive monitoring in the drainage that provides a robust baseline data set.
- Ulatis Creek at Brown Road (in the Cache Slough drainage) was selected to represent the drainages in the southern part of the subwatershed in Solano County. This drainage includes the dominant crops in the region and typically has year-round flows allowing sampling during irrigation season. There has already been extensive monitoring in the drainage that provides a robust baseline data set.
- Willow Slough Bypass at Pole Line (in the Willow Slough drainage) was selected to represent the drainages on the valley floor and foothills in central and eastern Yolo County. This drainage includes the dominant crops in the region and typically has year-round flows allowing sampling during irrigation season. There has already been extensive monitoring in the drainage that provides a robust baseline data set.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRP assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed for the representative drainages for all categories of MRP constituents by the end 2008 monitoring.

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
Toxicity, water	Cache Creek at Capay Diversion Dam			12	8	*20 (8)*[1]
	Shag Slough at Liberty Island Bridge	3	7	9	8	*27 (8)*[1]
	Toe Drain at NE corner of Little Holland	2				*2*
	Tule Canal at I-80	8				*8*
	Ulatis Creek at Brown Road		7	2	8	*17 (15)*[1]
	Willow Slough Bypass			11	8	*19 (8)*[1]
	Z Drain – Dixon RCD	9	7			*16 (15)*[1]
Toxicity, sediment	Cache Creek at Capay Diversion Dam			2	2	*4*
	Shag Slough at Liberty Island Bridge	1	2	2	2	*7*
	Tule Canal at I-80	3				*3*
	Ulatis Creek at Brown Road		2		2	*4*
	Willow Slough Bypass at SP			2	2	*4*
	Z Drain – Dixon RCD	3	2			*5*
Physical Parameters	Cache Creek at Capay Diversion Dam			7	2	*9*
	Shag Slough at Liberty Island Bridge	3	7	8	2	*20*
	Toe Drain at NE corner of Little Holland	2				*2*
	Tule Canal at I-80	8	7			*15*
	Willow Slough Bypass			8	2	*10*
	Ulatis Creek at Brown Road		7	7	2	*16*
	Z Drain – Dixon RCD	8	7			*15*
Pathogen Indicators	Cache Creek at Capay Diversion Dam			8	2	*10*
	Shag Slough at Liberty Island Bridge	3	7	8	2	*20*
	Toe Drain at NE corner of Little Holland	2				*2*
	Tule Canal at I-80	8	7	2		*17*
	Ulatis Creek at Brown Road		7	7	2	*16*
	Z Drain – Dixon RCD	7	7	2		*16*
	Willow Slough Bypass			8	2	*10*
Trace Metals	Cache Creek at Capay Diversion Dam			8	2	*10*
	Shag Slough at Liberty Island Bridge	3	7	8	2	*20*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	4	7			*11*
	Ulatis Creek at Brown Road		2	7	2	*11*
	Z Drain – Dixon RCD	4	7			*11*
	Willow Slough Bypass			8	2	*10*
Organophosphate Pesticides	Cache Creek at Capay Diversion Dam			9	2	*11*
	Shag Slough at Liberty Island Bridge	3	8	8	2	*21*
	Toe Drain at NE corner of Little Holland	2				*2*
	Tule Canal at I-80	8	8			*16*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Ulatis Creek at Brown Road		7	10	2	*19*
	Z Drain – Dixon RCD	8	7			*15*
	Willow Slough Bypass			11	2	*13*
Carbamates and Urea Pesticides	Cache Creek at Capay Diversion Dam			8	2	*10*
	Shag Slough at Liberty Island Bridge	3	7	8	2	*20*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	5	7			*12*
	Ulatis Creek at Brown Road			9	2	*11*
	Z Drain – Dixon RCD	5	7			*12*
	Willow Slough Bypass			8	2	*10*
Glyphosate	Cache Creek at Capay Diversion Dam			8	2	*10*
	Shag Slough at Liberty Island Bridge	3	7	8	2	*20*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	4	7			*11*
	Ulatis Creek at Brown Road			8	2	*10*
	Z Drain – Dixon RCD	4	7			*11*
	Willow Slough Bypass			8	2	*10*
Paraquat	Cache Creek at Capay Diversion Dam			7	2	*9*
	Shag Slough at Liberty Island Bridge	3	6	7	2	*18*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	4	6			*10*
	Ulatis Creek at Brown Road			7	2	*9*
	Z Drain – Dixon RCD	4	6			*10*
	Willow Slough Bypass			7	2	*9*
Triazine Herbicides	Cache Creek at Capay Diversion Dam			9	2	*11*
	Shag Slough at Liberty Island Bridge	3	8	9	2	*22*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	4	8			*12*
	Ulatis Creek at Brown Road			10	2	*12*
	Z Drain – Dixon RCD	4	7			*11*
	Willow Slough Bypass			9	2	*11*
Legacy Organochlorine Pesticides	Cache Creek at Capay Diversion Dam			9	2	*11*
	Shag Slough at Liberty Island Bridge	2	8	2	2	*14*
	Toe Drain at NE corner of Little Holland	1				*1*
	Tule Canal at I-80	3	8			*11*
	Ulatis Creek at Brown Road		6	9	2	*17*
	Z Drain – Dixon RCD	3	7			*10*
	Willow Slough Bypass			13	2	*15*
Nutrients	Cache Creek at Capay Diversion Dam			8	2	*10*
	Shag Slough at Liberty Island Bridge		7	8	2	*13*
	Tule Canal at I-80		7			*3*
	Ulatis Creek at Brown Road			7	2	*9*

MRP Monitoring Category	Site	2005	2006	2007	2008 Planned	*Total*
	Z Drain – Dixon RCD		7			*3*
	Willow Slough Bypass			8	2	*10*

1 Fathead minnows not monitored in 2007. Totals for fathead minnow tests are in parentheses for these sites.

Monitoring Sites

Proposed monitoring sites and schedule for MRP Assessment and Core monitoring, and Special Project studies or monitoring for management plans are listed in Table 2.

Table 2. Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Shag Slough at Liberty Island Bridge	38.3068N, 121.6934W	SSLIB	Core	Core	Assessment
Ulatis Creek at Brown Road	38.3070N, 121.7940W	UCBRD	Core & SP[1]	Core[2]	Assessment[2]
Willow Slough Bypass at Pole Line	38.5902N, 121.7306W	WLSPL	Core & SP[1]	Core[2]	Assessment[2]
Cache Cr. at Capay Diversion Dam	38.7137N, 122.0851W	CCCPY	SP only	TBD[2]	TBD[2]
Tule Canal at I-80	38.5728N, 121.5827W	TCHWY	SP only	TBD[2]	TBD[2]
Z Drain – Dixon RCD	38.4522N, 121.6752W	ZDDIX	SP only	TBD[2]	TBD[2]

1 "SP" indicates Special Project studies or monitoring for management plans

2 Special Project studies or monitoring may be continued depending on results for 2009

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d LISTED WATERBODIES

The Central Valley Water Board has listed waterbodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. Waterbodies listed as impaired in the Solano-Yolo subwatershed for pollutants with known or potential agricultural sources include the following.

- Sacramento River (Knights Landing to the Delta) for toxicity of unknown causes and for diazinon.

- Delta Waterways (northwestern portion) for toxicity of unknown causes
- Delta Waterways (northwestern portion) for chlorpyrifos and diazinon.
- Delta Waterways (northwestern portion) for legacy "Group A Pesticides" (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane, endosulfan, and toxaphene), and for DDT. None of these pesticides is currently registered for agricultural use in California.
- Delta Waterways (northwestern portion) for conductivity.
- Lower Cache Creek for toxicity of unknown causes (from Clear Lake Dam to Cache Creek Settling Basin near the Yolo Bypass).
- There are no listings for nutrients or pathogens.
- There are no listings of metals due to agricultural sources.

None of these 303d listings indicate a need for monitoring additional sites or parameters.

SITES WITH EXCEEDANCES REQUIRING MANAGEMENT PLANS

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	Registered Pesticides	Toxicity	E. coli	Legacy OC Pesticides	Metals	Salinity	DO	pH
Cache Cr. at Capay Diversion Dam		*Ceriodaphnia*			B[1]	X		
Ulatis Creek at Brown Road	Diuron	*Selensastrum*	X			X	X	X
Willow Slough Bypass at Pole Line	Chlorpyrifos	*Ceriodaphnia, Selenastrum*	X	X	B, Se	X		
Tule Canal at I-80			X		B	X		
Z Drain – Dixon RCD		*Hyalella*	X			X	X	X

1 B=Boron; Se=Selenium
2 Only one exceedance with greater than 20% effect

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in Table 4.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Sacramento River, Colusa Drain to I Street Bridge	E	E	E	E [WARM];E [COLD]
Yolo Bypass	—	E	E	E [WARM];P [COLD]
Cache Creek, Clear Lake to Yolo Bypass	E	E	E	E [WARM];P [COLD]
Putah Creek, Lake Berryessa to Yolo Bypass	E	E	E	E [WARM];E [COLD]
Sacramento-San Joaquin Delta	E	E	E	E [WARM];E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

Some of the water bodies monitored or proposed to be monitored by the Coalition do not have beneficial uses explicitly designated in the Basin Plan. However, the Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". All of the listed water bodies are direct or indirect tributaries to the northwestern Delta. Z-Drain and Tule Canal are within the Yolo Bypass and Willow Slough is tributary to the Yolo Bypass which specifically did not receive a MUN beneficial use. Ulatis Creek and Shag Slough are direct tributaries to the Delta through Cache Slough. Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in Table 5. Smaller tributaries that lack flow during dry months of the year are expected to support the WARM aquatic life beneficial use seasonally, but not the COLD aquatic life beneficial use.

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Cache Cr. at Capay Diversion Dam	E	E	E	E [WARM];P [COLD]
Shag Slough at Liberty Island Bridge	E	E	E	E [WARM];E [COLD]
Ulatis Creek at Brown Road	E	E	E	E [WARM];P [COLD]
Willow Slough Bypass at Pole Line	—	E	E	E [WARM];P [COLD]
Tule Canal at I-80	—	E	E	E [WARM];P [COLD]
Z Drain – Dixon RCD	—	E	E	E [WARM], seasonal

1 Assigned by default to water bodies without specific designated beneficial uses.
2 This water body is seasonally dry and does not support this beneficial use year-round.

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, and Timing of Application. The types of crops grown the Solano-Yolo Subwatershed represent the entire range of crops grown in the Sacramento Valley. **Appendix B: Calendars of Agricultural Activities** illustrates the activities associated with the predominant irrigated crops grown in the Solano-Yolo subwatershed. Calendars of farm operations are provided for alfalfa, fruit and nut orchards, grains, irrigated pasture, and vegetable crops. These crops account for over 90 percent of the irrigated croplands in the Solano-Yolo Subwatershed.

The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. Each calendar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides are included in **Appendix B (Agricultural Practices Calendar)**. This calendar highlights the major types of pesticides used for crop protection in the Solano-Yolo Subwatershed. Four major groups of pesticides that are essential to crop protection and that may affect water quality are used: insecticides, herbicides, fungicides, and copper compounds.

Agricultural uses of specific pesticides required to be monitored for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. Table 6 lists MRP pesticides used and the total acres treated in 2006. Total acreage treated per month is provided for each pesticide in Appendix C. MRP pesticides that were not used in the watershed are listed in Table 7**.** MRP Pesticides with no registered agricultural uses are listed in Table 8**.**

Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Carbamates	Carbaryl	6,068
	Carbamates	Carbofuran	1,907
	Carbamates	Methomyl	3,138
	Carbamates	Oxamyl	346
	Herbicides	Diuron	21,696
	Herbicides	Glyphosate	138,517
	Herbicides	Linuron	36
	Herbicides	Paraquat dichloride	47,495
	Herbicides	Simazine	1,422
	Herbicides	Trifluralin	51,333
	Metals	Copper	16,217
	Metals	Zinc	617
	Organochlorine	Dicofol	355
	Organophosphorus	Azinphos-methyl	544
	Organophosphorus	Diazinon	3,127
	Organophosphorus	Dimethoate	12,261
	Organophosphorus	Disulfoton	18
	Organophosphorus	Malathion	2,884
	Organophosphorus	Methamidophos	1,619
	Organophosphorus	Methyl parathion	206
	Organophosphorus	Naled	142
	Organophosphorus	Phosmet	368
Water and Sediment	Organophosphorus	Chlorpyrifos	18,938
Sediment	Pyrethroids	Bifenthrin	5,671

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
	Pyrethroids	Cyfluthrin	9,466
	Pyrethroids	Cypermethrin	1,288
	Pyrethroids	Esfenvalerate	13,948
	Pyrethroids	Fenpropathrin	989
	Pyrethroids	Lambda-cyhalothrin	46,460
	Pyrethroids	Permethrin	2,818

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Methiocarb
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Organophosphorus	Dichlorvos
	Organophosphorus	Demeton-s
	Organophosphorus	Methidathion
	Organophosphorus	Phorate
Sediment	Pyrethroids	Permethrin
	Pyrethroids	Fenpropathrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Water management practices used in the subwatershed include:

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management

- Runoff management

Implementation of water management practices for all counties in the Coalition watershed is documented in PRMS Reports in **Appendix D,** and typical schedules of irrigation are provided in the Agricultural Practices Calendar (**Appendix B**).

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

The recommended MRP sample frequency is year-round monthly monitoring. Because agricultural activities occur nearly year-round in the subwatershed, Assessment and Core Monitoring will be conducted monthly. Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns and data for the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected previously at the proposed monitoring sites and other monitored sites in the subwatershed.

Modifications for specific parameters are discussed in **Section 17 (Parameters to be Monitored)**.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space* *scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes*". See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS ()

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Nutrients

Nutrients will be monitored for Assessment and Core monitoring from February – November. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (Appendix B: Agricultural Activities Calendar).

Table 9. As discussed in **Section 12**, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and available data for the subwatershed. All MRP pesticides with significant use in the Subwatershed are monitored for Assessment monitoring. Modifications were made to the following parameter categories:

Physical and Microbiological Parameters

Hardness

Hardness will be monitored on the same schedule as trace metals (December - June) because the only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Fecal coliforms and E. coli

Fecal coliforms and *E. coli* will be monitored monthly during assessment and core monitoring, and studied for Special Projects as required by the Coalition Management Plan currently under development.

Toxicity

Water column toxicity testing will be conducted monthly during Assessment monitoring from December – August with *Selenastrum*, and from January – September with *Ceriodaphnia* and *Pimephales*. This schedule for monitoring aquatic toxicity is based on the following.

- The January – September period covers the period of insecticide applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Ceriodaphnia*, primarily).
- There is negligible use of insecticides by irrigated agricultural from September through December and little risk of runoff.
- The December – August period covers the period of herbicide and copper applications with the greatest potential to cause toxicity to the test species most sensitive to these compounds (*Selenastrum*).
- These toxicity monitoring periods include the months with the greatest potential for runoff of insecticides and herbicides due to storm events (January – March).

Sediment toxicity will be monitored with *Hyalella* in April and August during Assessment periods.

Carbamates

Several carbamate pesticides listed in the MRP were not used or received very limited use in the subwatershed. There was no reported use of aldicarb or methiocarb. Oxamyl was applied to less than 0.1% of the total irrigated acres. Carbaryl and methomyl were the most widely used carbamates and were applied to approximately 0.8% and 0.4% percent of the total irrigated acres, respectively. Based on use patterns, sampling from May – October would provide a comprehensive monitoring schedule for carbamates, and would cover ~98% of the carbaryl and methomyl applications specifically. Because these pesticides are part of the scan also used to analyze for urea-substituted herbicides (e.g., diuron), carbamates will also be monitored in additional months when their use is extremely low.

Organochlorines

Legacy organochlorine pesticides will be monitored in water samples during the storm season (December through March) during Assessment periods and as required for Special Project monitoring. The Assessment schedule for monitoring organochlorine pesticides is based on the following.

- There were limited agricultural applications of the only registered pesticide in this category (Dicofol), which was applied to less than 0.1% of the total irrigated acreage in the subwatershed (345 of 745,208 total irrigated acres). All Dicofol applications occurred during dry season months (July – September)) with low potential for runoff from irrigated land.
- Dicofol has not been detected in any samples from this subwatershed.
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently they are transported primarily through erosion processes associated with high flows that typically occur in the storm season.

Organophosphorus Pesticides

Organophosphorus pesticides will be monitored January through September. This period was selected based on the application pattern for the five organophosphorus pesticides that were widely applied (chlorpyrifos, diazinon, dimethoate, malathion, and methamidophos). These five pesticides accounted for approximately 97% of the irrigated acreage treated with organophosphorus pesticides. These five pesticides had very low application rates from October through December, a period when risk of runoff is also very low. Other pesticides in this category were applied to less than 0.1% of the total irrigated acreage and were not detected in subwatershed samples, or had no reported applications. The January – September monitoring period accounts for more than 95% of all applications of organophosphorus pesticides and includes the storm season when the risk of runoff is highest (January – March).

Herbicides

Diuron, glyphosate, paraquat, and trifluralin were all widely used herbicides in this subwatershed, and simazine had some limited use. Atrazine and cyanazine were not used in this subwatershed, and linuron was applied to only 36 acres in 2006 (~ 0.005% of the total irrigated acres). Diuron will be monitored from December – March (~98% of applications). Glyphosate will be monitored from December – June (~90% of applications). Paraquat will be monitored from December – September (~98% of applications). Simazine will be monitored from December – May (~99% of applications). Trifluralin will be monitored from January – June (95% of applications). This monitoring schedule accounts for more than 95% of the total acreage treated with these herbicides and includes the storm season when the potential for runoff is highest. Most other pesticides in this category were applied to less than 0.1% of the total irrigated acreage, or had no reported applications. Because diuron and linuron are part of the scan also used to analyze for carbamates, these urea-substituted herbicides will also be monitored in additional months when their use is extremely low.

Metals and Metalloids

Copper will be monitored in water samples from December through June. Other trace metals will be monitored during the storm season (December through March). This schedule for monitoring metals is based on the following.

- Copper is the only metal with significant agricultural applications, with the majority of applications on rice crops, grapes, walnuts, and tomatoes. This monitoring schedule accounts for ~96% of the total acreage treated with copper and includes the storm season when the potential for runoff is highest. In spite of relatively widespread agricultural use of copper, there have not been any exceedances in the subwatershed.
- Zinc was applied to less than 0.1% of irrigated acres, with most applications during the dry season. Applications during storm season would be captured during the scheduled sampling. This agricultural use of zinc has not resulted in any observed exceedances in the subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosion processes associated with high flows that typically occur in the storm season.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. Boron and selenium are the only trace metals with observed exceedances in the subwatershed. The absence of exceedances of water quality objectives for other MRP trace metals in prior Coalition monitoring in indicates that these trace metals are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the period of highest agricultural use (of copper) and highest risk of erosion transport is sufficient to evaluate the risk of impacts from elevated metals concentrations. Boron and selenium will also receive additional Special Project study or monitoring as required for the management plan.
- Hardness will be monitored on the same schedule as trace metals. The only relevant use of this parameter is for interpreting and evaluating trace metals toxicity and compliance with water quality objectives.

Nutrients

Nutrients will be monitored for Assessment and Core monitoring from February – November. This schedule includes the typical periods of applications for the dominant crops in this subwatershed (Appendix B: Agricultural Activities Calendar).

Table 9. MRP Parameters to be monitored in the Solano-Yolo subwatershed

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	Monthly
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	Monthly
pH (field measure)	Assessment and Core	Monthly
Electrical Conductivity (field measure)	Assessment and Core	Monthly
Dissolved Oxygen (field measure)	Assessment and Core	Monthly
Temperature (field measure)	Assessment and Core	Monthly
Turbidity	Assessment and Core	Monthly

Monitoring Parameters	Monitoring Type	Schedule
Total Dissolved Solids	Assessment and Core	Monthly
Total Suspended Solids	Assessment and Core	Monthly
Hardness	Assessment and Core	DEC-JUN (for metals)
Total Organic Carbon	Assessment and Core	Monthly
Pathogens		
Fecal coliform	Assessment, Core, SP	Monthly
E. coli	Assessment, Core, SP	Monthly
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	DEC-AUG
Water Flea - *Ceriodaphnia*	Assessment	JAN-SEP
Fathead Minnow - *Pimephales*	Assessment	JAN-SEP
Pesticides		
Carbamates		
Aldicarb	Assessment	None [not used]
Carbaryl	Assessment	MAY-SEP
Carbofuran	Assessment	FEB-MAR
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	MAY-OCT
Oxamyl	Assessment	None [Insufficient use]
Organochlorines		
DDD	Assessment and SP	DEC-MAR (Storm Season)
DDE	Assessment and SP	DEC-MAR (Storm Season)
DDT	Assessment and SP	DEC-MAR (Storm Season)
Dicofol	Assessment	None [Insufficient Use]
Dieldrin	Assessment and SP	DEC-MAR (Storm Season)
Endrin	Assessment and SP	DEC-MAR (Storm Season)
Methoxychlor	Assessment and SP	DEC-MAR (Storm Season)
Organophosphorus		
Azinphos-methyl	Assessment	None [Insufficient Use]
Chlorpyrifos	Assessment	JAN-SEP
Diazinon	Assessment	JAN-AUG
Dichlorvos (Naled breakdown product)	Assessment	None [Insufficient Use]
Dimethoate	Assessment	MAY-SEP
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyston)	Assessment	None [Insufficient Use]
Malathion	Assessment	MAR-SEP
Methamidophos	Assessment	JUL-SEP
Methidathion	Assessment	None [Not Used]
Parathion-methyl	Assessment	None [Insufficient Use]
Phorate	Assessment	None [Not Used]
Phosmet	Assessment	None [Insufficient Use]
Herbicides		
Atrazine	Assessment	None [Not Used]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	DEC-MAR
Glyphosate	Assessment	DEC-JUN
Linuron	Assessment	None [Insufficient Use]
Paraquat dichloride	Assessment	DEC-SEP
Simazine	Assessment	DEC-MAY
Trifluralin	Assessment	JAN-JUN
Metals		

Monitoring Parameters	Monitoring Type	Schedule
Arsenic (total)	Assessment	DEC-MAR (Storm Season)
Boron (total)	Assessment, SP	DEC-MAR (Storm Season)
Cadmium (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Copper (total and dissolved)	Assessment	DEC-JUN
Lead (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nickel (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Molybdenum (total)	Assessment	DEC-MAR (Storm Season)
Selenium (total)	Assessment, SP	DEC-MAR (Storm Season)
Zinc (total and dissolved)	Assessment	DEC-MAR (Storm Season)
Nutrients -		
Total Kjeldahl Nitrogen	Assessment and Core	FEB-NOV
Nitrate plus Nitrite as Nitrogen	Assessment and Core	
Total Ammonia	Assessment and Core	
Unionized Ammonia (calculated value)	Assessment and Core	
Total Phosphorous (as P)	Assessment and Core	
Soluble Orthophosphate	Assessment and Core	
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	APR, AUG
Pesticides		
Bifenthrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin		
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity
Grain Size	Assessment	with sediment toxicity

QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

COALITION GROUP CONTACT INFORMATION

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan

18.

Upper Feather River Subwatershed MRPP

1. MONITORING STRATEGY

The overall ILRP monitoring strategy for the Sacramento Valley Water Quality Coalition (Coalition) is provided in the *SVWQC MRPP Overview*.

2. DESCRIPTION OF THE SUBWATERSHED

The characteristics of the subwatershed relevant to the ILRP (geography, climate, hydrology patterns, land use, soils, and crops) are provided in the *SVWQC MRPP Overview.*

3. MONITORING SITES

Representation and Rationale

Three sites were selected to represent the crops and cultural practices in the UFR subwatershed. Core and assessment monitoring will be conducted at these sites which are located below irrigated agriculture activities occurring within Indian Valley, American Valley, and Sierra Valley. These sites represent over 90% of the irrigated agricultural activities occurring in the sub-watershed, and are representative of water quality and agricultural activities occurring in the remaining portion of the sub-watershed (e.g., Long Valley, Mohawk Valley, Goodrich Creek). In addition, assessment level monitoring data (e.g., toxicity, physical, chemical, microbiological constituents) has been collected at these 3 sites from 2004 through 2008 for compliance with the Irrigated Lands Program, and as part of the Proposition 50 funded project "*Upper Feather River Watershed (UFRW) Irrigation Discharge Management Program*" SWRCB Agreement 04-317-555-0 with the Regents of the University of California. Thus, significant data exist to examine water quality trends across years and seasonally within years for these sites. We propose to build upon this database, and use it to guide future monitoring and management practice implementation.

Monitoring Completed

For the purpose of developing this MRPP, completion of MRPs assessment requirements has been defined by Water Board staff as completion of the equivalent of one full year of monitoring for all MRP constituents in the currently applicable MRP. This typically consists of 2 storm and 6 dry season events, and may incorporate consideration of exceptions in approved monitoring plans and consolidation of data for similar sites and drainages. Ongoing and planned monitoring for 2008 was also considered in this evaluation.

Review of the monitoring results indicates that the requirements for assessment monitoring have been completed or will be completed at all three monitoring sites for categories of MRP constituents relevant to this subwatershed by the end 2008 monitoring. These categories include physical, microbiological, toxicity in water and sediment, trace metals, and nutrients. Monitoring of registered pesticides was not included in the approved monitoring plans or conducted due to extremely low use in this subwatershed. Monitoring of legacy organochlorine pesticides was not included in the approved monitoring plans or conducted due to the absence of 303d listings for these compounds in the subwatershed.

Monitoring sites on all three water bodies have been modified over the course of the Coalition's ILRP monitoring, with two locations monitored on each water body. In each case, the change in site location was minimal and improved or did not significantly change the representation for the water body. Consequently, the results for different sites on the three water bodies were consolidated for the evaluation of monitoring completed (Table 1).

Table 1. Monitoring Completed in Subwatershed Waterbodies

MRP Monitoring Category	Site	2005	2006	2007	2008 planned
Physical, Microbiological	Middle Fork Feather River	6	10	8	7
	Spanish Creek	7	10	7	7
	Indian Creek	7	10	7	7
Toxicity, water	Middle Fork Feather River	—	5	1	—
	Spanish Creek	—	5	1	—
	Indian Creek	—	5	1	—
Toxicity, sediment	Middle Fork Feather River	—	1	2	—
	Spanish Creek	—	1	2	—
	Indian Creek	—	1	2	—
Metals	Middle Fork Feather River	—	6	—	—
	Spanish Creek	—	6	—	—
	Indian Creek	—	6	—	—
Organophosphorus pesticides	Middle Fork Feather River Spanish Creek Indian Creek	*Organophosphorus pesticides were not monitored at these sites due to low use in this watershed*			
Carbamate pesticides	Middle Fork Feather River Spanish Creek Indian Creek	*Carbamate pesticides were not monitored at these sites due to low use in this watershed*			
Herbicides	Middle Fork Feather River Spanish Creek Indian Creek	*Herbicides were not monitored at these sites based on low use in this watershed*			
Organochlorine pesticides	Middle Fork Feather River Spanish Creek Indian Creek	*Legacy pesticides were not monitored at these sites based on absence of 303d listings in these drainages*			
Nutrients	Middle Fork Feather River	6	10	8	7
	Spanish Creek	7	10	7	7
	Indian Creek	7	10	7	7

Monitoring Sites

Proposed monitoring sites and the schedule for MRP Assessment and Core monitoring are listed in Table 2.

Table 2. Upper Feather River Subwatershed Monitoring Sites and Schedule, 2009 - 2011

Site Description	Lat, Long	Site ID	2009	2010	2011
Middle Fork Feather River above confluence with Grizzly Creek	39.816N, 120.426W	MFFGR	Core + SP[1]	Core	Assessment
Spanish Creek below confluence with Greenhorn Creek	39.9735N, 120.9103W	SPGRN	Core + SP[1]	Core	Assessment
Indian Creek below Arlington	40.0846N,	INDAP	Core + SP[1]	Core	Assessment

Bridge	120.9161W

(1) SP indicates Special Project studies or monitoring for management plans. UFRW is conducting special studies for DO and pH exceedances in 2008. If the results of these studies resolve the questions for these parameters, additional Special Project monitoring will not be required.

4. WATER QUALITY IMPAIRMENTS AND WATER QUALITY LIMITED WATER BODIES

It is a requirement of the MRP to identify "known and potential" water quality impairments and water quality limited water bodies. For the purpose of this MRPP, these known and potential impairments are evaluated based on 303(d) listings in the subwatershed and on the Coalition's ILRP monitoring results. These evaluations are intended to address in part MRP Question #1: "Are conditions in waters of the State that receive discharges of wastes from irrigated lands within Coalition Group boundaries, as a result of activities within those boundaries, protective of beneficial uses?"

303d Listed Waterbodies

The Central Valley Water Board has listed water bodies in the Central Valley as impaired for the following "pollutant" categories: hydromodification, metals/metalloids, miscellaneous, nuisance, nutrients, other inorganics, other organics, pathogens, pesticides, salinity, sediment, toxicity, and trash. There are currently no water bodies listed as impaired in the Upper Feather River subwatershed for pollutants with known or potential agricultural sources, and no 303d listings that indicate a need for monitoring additional sites or parameters.

Sites With Exceedances Requiring Management Plans

Based on ILRP data collected through March 2008, two or more exceedances of the parameters identified in Table 3 have been observed for sites monitored in this subwatershed. Special project monitoring or studies to address these exceedances will be addressed in the Coalition Management Plan as required by the ILRP.

Table 3. Special Study or Special Project Monitoring Elements

Site Description	E. coli	DO	pH
Middle Fork Feather River		X	X
Spanish Creek	X	X	X
Indian Creek	X	X	X

5. DESIGNATED BENEFICIAL USES

Specific beneficial uses have been designated in the Central Valley Basin Plan only for the Sacramento River and direct perennial tributaries to the Sacramento River in this subwatershed. Designated beneficial uses that are relevant to the implementation of the ILRP are municipal and domestic water supply (MUN), agricultural water supply (AGR), contact recreation (REC-1), and aquatic life uses including freshwater habitat, migration, and spawning for cold water and warm water species (WARM, COLD). Water bodies with specifically designated uses in the subwatershed are listed in the table below.

Table 4. Beneficial Uses Designated in the Central Valley Basin Plan

Site Description	MUN	AGR	REC1	Freshwater Habitat [WARM/COLD]
Lake Almanor	—	—	E	E
North Fork Feather River	E	—	E	E
Middle Fork Feather River				
Source to Little Last Chance Creek	—	E	E	E
Frenchman Reservoir	—	—	—	P [WARM], E [COLD]
Little Last Chance Creek to Lake Oroville	E	—	E	E
Lake Davis	—	—	E	P [WARM], E [COLD]
Lakes Basin Lakes	—	—	E	E [COLD]

E Indicates Existing Beneficial Use
P Indicates Potential Beneficial Use

The Middle Fork of the Feather River above the confluence with Grizzly Creek has beneficial uses explicitly designated in the Basin Plan (MUN, REC1, and COLD and WARM aquatic life habitat).

Spanish Creek and Indian Creek do not have beneficial uses explicitly designated in the Basin Plan. Spanish Creek and Indian Creek are tributary to the East Branch of the North Fork of the Feather River. The North Fork of the Feather River does have beneficial uses explicitly designated in the Basin Plan (MUN, REC1, and COLD and WARM aquatic life habitat). The Basin Plan states that "*…beneficial uses of any specifically identified water body generally apply to its tributary streams*" and also that "*Water Bodies within the basins that do not have beneficial uses designated in Table II-1 are assigned MUN designations…*". Based on these provisions of the Basin Plan, water bodies proposed to be monitored for this MRPP are expected to support or have the potential to support MUN, AGR, REC-1, and COLD or WARM aquatic life beneficial uses at least seasonally, as indicated in the table below. Although AGR is not specifically identified as a beneficial use of the Middle Fork Feather River or North Fork Feather River in the Basin Plan, the three water bodies that will be monitored by the Coalition are known to support this use (based on empirical observation).

Table 5. Beneficial Uses for Coalition Monitoring Sites

Site Description	MUN[1]	AGR	REC1	FRESH [WARM/COLD]
Middle Fork Feather River above confluence with Grizzly Creek	E	E[2]	E	E
Spanish Creek below confluence with Greenhorn Creek	E	E[2]	E	E
Indian Creek below Arlington Bridge	E	E[2]	E	E

1 Assigned by default to water bodies without specific designated beneficial uses.
2 Not identified as a beneficial use of the Middle Fork Feather River or North Fork Feather River in the Basin Plan

6. MAP(S) OF THE COALITION AREA

Maps indicating irrigated lands, identifying crop type(s), monitoring sites, main water bodies, tributaries, canals, channels, and drainages are provided in **Appendix A**. Representation by the monitoring sites in this subwatershed of unmonitored drainages and land uses are indicated in the drainage representation maps.

7. TRANSPORT, FATE, AND EFFECTS OF KEY POLLUTANTS

The primary factors relevant to the fate and transport of MRP monitoring parameters are the physical characteristics of chemicals that govern whether they are more likely to be found and transported in water or in sediment. Chemicals that are highly soluble in water (e.g., arsenic, glyphosate, and most salts) are more easily dissolved from soils and transported in runoff and irrigation return flows. Chemicals that are relatively insoluble or extremely hydrophobic (e.g., lead, most pyrethroid pesticides, legacy organochlorines) tend to be associated with sediment and soil particles and are transported mainly during by flows that result in erosion and particle transport. Because hydrophobic compounds partition primarily to soils and sediments, these chemicals are less available in the water column and their potential adverse effects are more effectively monitored in sediments (e.g., sediment testing for pyrethroid toxicity). Because transport of hydrophobic and relatively insoluble compounds occurs primarily through erosion associated with higher runoff flows, monitoring of these chemicals can be focused during or immediately after periods with greater risk of high flows and erosive transport (winter storm season in most subwatersheds, or during spring snow melt in higher elevation subwatersheds).

8. CUMULATIVE AND INDIRECT EFFECTS, AND OTHER FACTORS AFFECTING WATER QUALITY

The MRP requires consideration of cumulative and indirect effects in developing an appropriate Coalition MRPP. The potential interactions of multiple physical, chemical, and biological stressors are generally too numerous and complex to address with direct analysis of specific parameters or sampling conditions. Consequently, cumulative, additive, synergistic, antagonistic, and other indirect effects of multiple stressors are monitored empirically by toxicity testing of water and sediment. Toxicity testing inherently measures the simultaneous effect and interaction of all the potential stressors in a water sample. Toxicity Identification Evaluations or other follow-up evaluations are conducted on samples that meet specified toxicity triggers. However, it is recognized that these evaluations often may not be able to identify the specific factors contributing to effects if all stressors are below individual effect levels.

9. PESTICIDE USE

Production Practices, Chemical Use, Chemical Application Methods, and Timing of Application. There is a limited range of crops grown in the Upper Feather River Subwatershed. As discussed previously, the predominant agricultural activities in the subwatershed are: 1) beef cattle grazing on irrigated pastures and non-irrigated rangelands during the summer growing season; 2) harvest of irrigated native meadow and irrigated alfalfa hay during the summer growing season; and 3) over-wintering of less than 800 beef cattle by feeding hay. These crops account for over 90 percent of the irrigated croplands in the subwatershed.

Appendix B (Calendars of Agricultural Activities) documents the cultural activities and practices associated with the crops grown in the subwatershed. The farm operations highlighted in these calendars may change as new knowledge and technology becomes available. The Caledar lists management practices that have a reasonable probability of occurring for that specific crop. The approximate timing of each management operation is also specified. Irrigated crops are complex biological systems, which make it difficult to accurately predict every management practice. Furthermore, not all of the management practices listed in each calendar will be implemented in every field every year. Site-specific conditions will determine if a specific management practice is necessary.

General patterns of use for insecticides, herbicides, and fungicides used in the subwatershed are provided in **Appendix B (Agricultural Practices Calendar)**. This appendix highlights the major types and timing of pesticides used for crop protection in the subwatershed. Use of agricultural pesticides is extremely low within the Upper Feather river subwatershed, and is negligible compared to other reported uses. The overwhelming majority of pesticides are applied for forest and timberland management, right of way maintenance, and landscape maintenance (illustrated for Plumas County in **Figure 1**).

There were no reported applications of metals associated with any agricultural practices in the UFRW. Metals analysis performed on samples collected during 2005 through 2006 revealed no metals near levels of concern. We will monitor changes in agricultural practices and annual pesticide use within the UFRW on an annual basis. If there is an increase in agricultural practices dependent upon pesticide and/or metal applications, and/or an increase in reported pesticide use we will evaluate the need to reinstitute toxicity and/or metals monitoring as a part of future Assessment monitoring efforts.

Agricultural uses of specific pesticides required for the MRP were evaluated using the California Department of Pesticide Regulation's 2006 Pesticide Use Reporting database. **Table 8** lists MRP pesticides used and the total acres treated in 2006. The only reported agricultural applications of pesticides in 2006 were of Glyphosate (Round-Up™), and 87% of that total acreage categorized as agricultural applications was forest land. Only 187 acres of pasture and alfalfa were treated with Glyphosate in 2006. Total agricultural acreage treated per month for each pesticide used is provided in **Appendix C**. MRP pesticides that were not used are listed in **Table 9**. MRP legacy pesticides with no registered agricultural uses are listed in **Table 10**. Based on the limited use of pesticides in this subwatershed, no monitoring of these parameters is planned for the MRPP.

Figure 1. Pesticide use data for Plumas County 2000 through 2005, by major land use category. Data from Department of Pesticide Regulation (DPR) – http://www.cd.pr.ca.gov

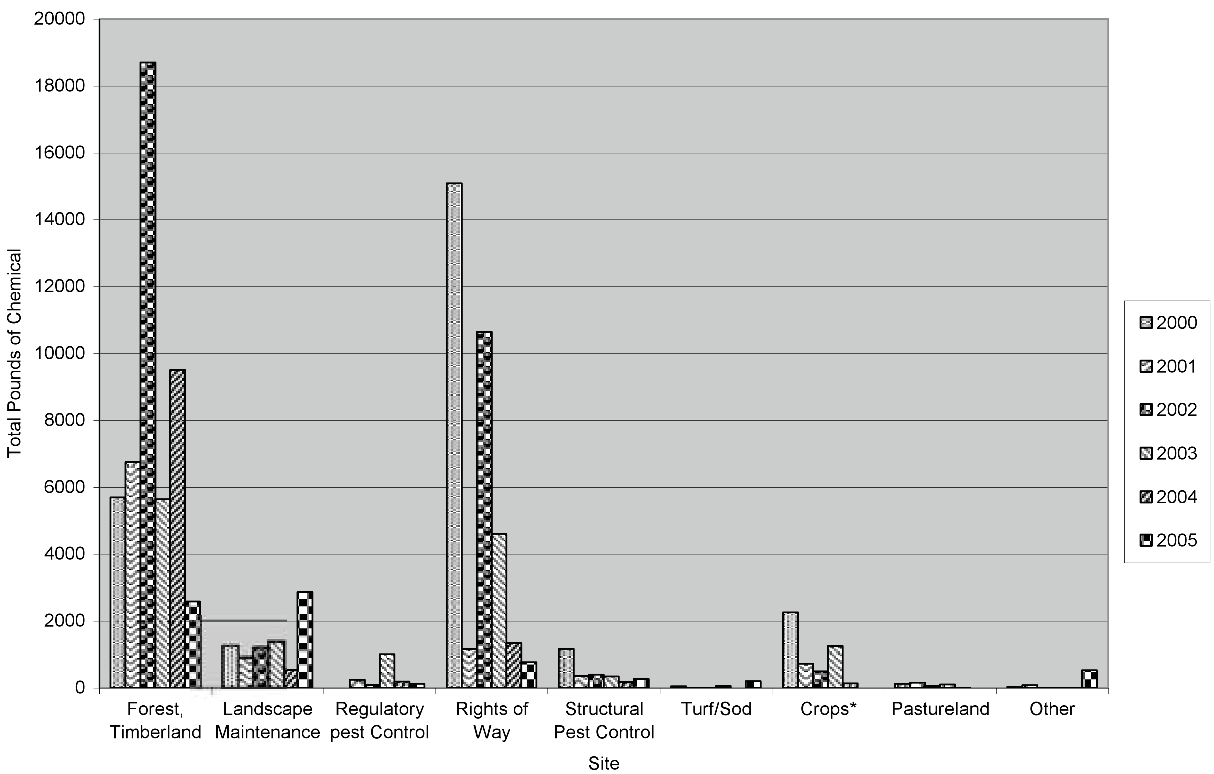


Table 6. MRP Pesticide Use Reported for 2006

Monitoring Matrix	MRPP Category	Chemical	Total Acres Treated, 2006
Water	Herbicides	Glyphosate	1523*

* Includes application to 1,313 acres categorized as *Agriculture* in the CDPR PUR Database

Table 7. MRP Pesticides With No Reported Use in 2006

Monitoring Matrix	MRPP Category	Chemical
Water	Carbamates	Aldicarb
	Carbamates	Carbaryl
	Carbamates	Carbofuran
	Carbamates	Methiocarb
	Carbamates	Methomyl
	Carbamates	Oxamyl
	Herbicides	Atrazine
	Herbicides	Cyanazine
	Herbicides	Diuron
	Herbicides	Glyphosate
	Herbicides	Linuron

Monitoring Matrix	MRPP Category	Chemical
	Herbicides	Paraquat dichloride
	Herbicides	Simazine
	Herbicides	Trifluralin
	Organochlorine	Dicofol
	Organophosphorus	Azinphos-methyl
	Organophosphorus	Demeton-s
	Organophosphorus	Diazinon
	Organophosphorus	Dichlorvos
	Organophosphorus	Dimethoate
	Organophosphorus	Disulfoton (Disyton)
	Organophosphorus	Malathion
	Organophosphorus	Methamidophos
	Organophosphorus	Methidathion
	Organophosphorus	Methyl parathion
	Organophosphorus	Phorate
	Organophosphorus	Phosmet
Water & Sediment	Organophosphorus	Chlorpyrifos
Sediment	Pyrethroids	Cypermethrin
Sediment	Pyrethroids	Bifenthrin
	Pyrethroids	Cyfluthrin
	Pyrethroids	Esfenvalerate
	Pyrethroids	Fenpropathrin
	Pyrethroids	Lambda-cyhalothrin
	Pyrethroids	Permethrin

Table 8. MRP Legacy Pesticides With No Registered Uses

Monitoring Matrix	MRPP Category	Chemical
Water	Organochlorines	DDD
	Organochlorines	DDE
	Organochlorines	DDT
	Organochlorines	Dieldrin
	Organochlorines	Endrin
	Organochlorines	Methoxychlor

10. WATER MANAGEMENT PRACTICES

Documented in Agricultural Practices Calendar Reports…

- Crop hydration (irrigation)
- Pre-planting irrigation
- Frost prevention
- Salinity management

11. MANAGEMENT PRACTICES

Chemical application methods are discussed in the *SVWQC MRPP Overview*. Specific applicator training and specific approaches to pesticide application in orchard crops, field/row crops, and irrigated pasture are briefly discussed.

A summary of PRMS Report Data summarizing management practices implemented for all counties in the Coalition watershed is provided in **Appendix D**.

Water Quality Improvement Programs and Techniques Associated with Discharges from Irrigated Lands

NRCS and RCD Programs: The Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD) support a variety of programs to assist with the use of Best Management Practices (BMP's) on irrigated croplands. They include:

- Cost sharing of irrigation system improvements
- Drainage channel restoration and stabilization practices
- Irrigation Mobile Lab Service – an on-farm evaluation of irrigation system uniformity, management practices, maintenance.

In addition, please refer to *SVWQC MRPP Overview* for an Inventory of Management Practices and Projects common to the subwatershed.

12. MONITORING PERIODS

Assessment and Core Monitoring will be conducted monthly from May through September (5 months). Monitoring in 2009 and 2010 will include Core Monitoring and Special Project monitoring, as required for Management Plans. Modifications to monitoring schedules and frequency for specific parameters were based primarily on the following:

- Pesticide application patterns in the subwatershed
- Cultural practices for the dominant crops in the region
- Water quality data collected at the 3 proposed monitoring sites and 16 additional monitoring sites during 2005, 2006, and 2007
- Published research relevant to the sub-watershed and the type of agricultural activities occurring in the sub-watershed.

The recommended MRP sample frequency is year-round monthly monitoring. However, during winter months in the UFRW (November through March) sampling is generally not feasible due to:

1) Snow covered conditions across much of the subwatershed and limited runoff from agricultural areas;
2) Surface ice and frozen in-stream conditions at sample locations which preclude safe or representative sample collection;
3) Lack of irrigated agricultural activity during this period;
4) Previously conducted winter sampling at these three sample locations conducted from 2005 through 2007 revealed no exceedances for any constituents required for ILP monitoring.

Consequently, sampling is proposed to begin during the higher runoff and flows associated with mid-spring snowmelt runoff (May) and continue through the irrigation season.

13. BIAS AND VARIABILITY AND MONITORING DESIGN

The MRP monitoring guidance document specifies that the MRPP should consider… "*Information about sources of bias and variability, especially over different time and space scales, that could affect the validity of a monitoring design and/or the reliability of monitoring data. This information may be qualitative or quantitative, depending on the specific requirements of the relevant monitoring design process*."

In the context of the requirements of the MRPP, there has been a decision to focus monitoring on drainages and periods for which the risk of exceedances and toxicity from agricultural sources is greatest. This was done to provide a monitoring program that efficiently identifies water quality problems that require management. This focus will consequently result in a negatively biased characterization of agricultural water quality that will tend to over-represent the frequency and distribution of problems due to agriculture. This bias is considered acceptable for the purpose creating a cost-efficient program to identify and address potential water quality problems.

The large range of spatial variability that occurs on a watershed scale was address by subdividing the Coalition watershed into ten more homogeneous subwatersheds with relatively consistent geographic, climate, and agricultural characteristics. Spatial variability in agricultural sources and runoff within a subwatershed is addressed primarily by selecting locations with a diversity of crops that are representative of larger areas and drainages. Although there is variability in the proportions of crops and the cultural practices within the drainages, the monitoring sites were selected to minimize this variability by representing drainages that were qualitatively most similar in crops, hydrology, climate, and geographic proximity. Sites were also selected to be large enough that they would typically include multiple growers of similar crops and thus be able to characterize an "average" or "typical" runoff quality that is expected to be less variable than runoff from individual growers.

Temporal variability of concern to the MRPP occurs on daily, seasonal, annual, and longer cycles. Annual and seasonal variability scales are the most relevant to the program and are explicitly considered in the monitoring design. Annual variations and longer-term trends are addressed primarily by implementing a ongoing, consistent and well-designed program, and reassessing water quality over a three year cycle. Consistent seasonal variation in climate and agricultural practices are acknowledged and addressed by considering the typical schedules for rainfall and runoff, and their interaction with pesticide and nutrient application patterns. Because samples are collected essentially as instantaneous grab samples, daily and shorter-term variability will affect the results of individual samples. For most processes and pollutants of concern to the program, this short-term variation is essentially random and somewhat moderated by monitoring in drainages that are large enough to "smooth out" temporal variation at this scale. Systematic short-term variations (e.g., temperature, dissolved oxygen, and pH and algal respirations cycles) will also affect results and may require additional effort to adequately characterize the temporal patterns of related water quality problems.

14. SPATIAL AND TEMPORAL RESOLUTION

The MRP monitoring guidance document specifies that the MRPP should also consider… "*Qualitative information about spatial and temporal resolution required for reliable descriptions of basic patterns and processes"*. See Sections 13 and 14 for a discussion of spatial and temporal resolution and how they are addressed in the monitoring design.

15. DEFINITION OF ACCEPTABLE LEVELS OF UNCERTAINTY ABOUT THE SOURCES, MECHANISMS, LOCATIONS, AND SCALE OF POTENTIAL IMPACTS

This monitoring design described in this MRPP relies on representative locations and monitoring periods to evaluate water quality and sources of pollutants that may adversely affect water quality. The representative design necessarily includes some unknown degree of uncertainty regarding the sources, mechanisms, locations, and scale of potential impacts in unmonitored drainages and water bodies. This degree of uncertainty is generally tolerated to allow a cost-effective monitoring program. When the degree of uncertainty is too large to make significant decisions regarding implementation of management actions, additional monitoring can be implemented through the Coalition's Management Plan to reduce the uncertainty to an acceptable level.

16. DATA ANALYSIS METHODS

The primary methods used to evaluate and analyze the results of the coalition's MRPP results are:

- Comparisons of results to adopted numeric water quality criteria and objectives (Central Valley Basin Plan, California Toxics Rule)
- Comparisons to numeric interpretations of adopted narrative water quality objectives (e.g., "*no toxics in toxic amounts…* ")
- Comparisons of concentrations to known effect levels for specific pesticides and other toxic parameters
- Qualitative association of site conditions (flow, temperature, algae, source water quality) to related MRP parameters (e.g., DO, pH, conductivity).

Additionally, on a case-by-case basis, a more rigorous statistical or quantitative analysis of Coalition results and other monitoring data may be conducted to evaluate sources of pollutants or causes or exceedances.

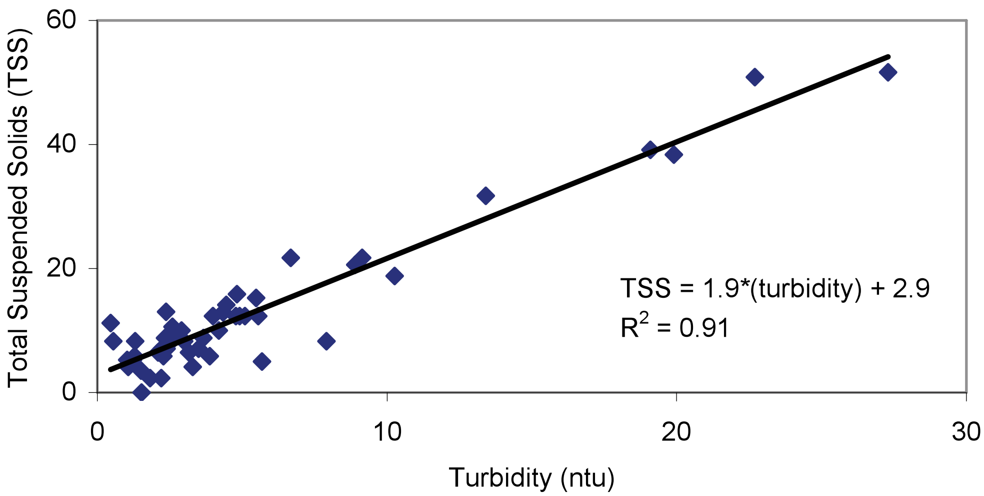
17. PARAMETERS TO BE MONITORED

Parameters to be monitored for assessment and core monitoring are indicated in Table 9, along with the planned monthly schedule for each parameter. As discussed previously, modifications to frequency and schedule of monitoring for specific parameters are based on patterns of cultural practices, pesticide applications, and previous monitoring results. All MRP pesticides with significant use in the Subwatershed are monitored for assessment monitoring. In the case of the Upper Feather River subwatershed, there were no significant agricultural applications of MRP pesticides. Modifications of the schedule and rationale for specific parameter categories are provided in the following sections.

Physical and Microbiological Parameters

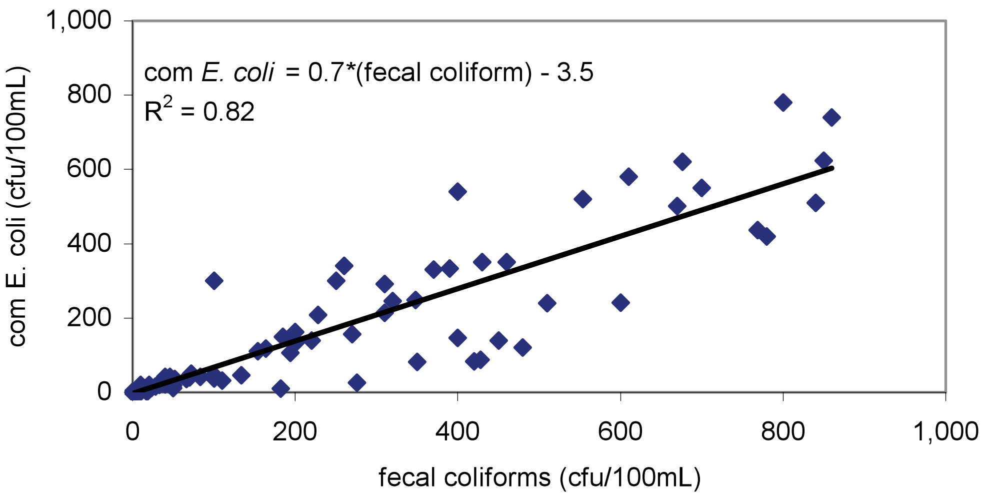
Total Suspended Solids. Total suspended solids will be estimated from turbidity measurements taken with a portable laboratory turbidity meter (Orbeco-Helige Portable Turbidimeter Model 966). Figure 2 displays the relationship developed between turbidity (NTU) and total suspended solids (mg/L) based upon data collected during 2006 and 2007 at all 3 UFRW monitoring locations. During the 2008 irrigation season, specific suspended solid analysis (total, organic, and mineral) will also be conducted on samples collected as part of a special monitoring project to understand factors driving dissolved oxygen and pH concentrations at the Sierra Valley and Indian Valley monitoring locations.

Figure 2. Correlation between turbidity and total suspended solids for UFRW monitoring locations. Data from Sierra Valley, Indian Valley, and American Valley 2006 and 2007.



Fecal coliforms. USEPA recommends commensal *E. coli* as the most appropriate indicator of fecal derived pathogens. As part of the ILRP, a substantial data set of baseline data has been developed for commensal *E. coli* at the 3 UFRW monitoring locations during the 2005 through 2007 irrigation and wet seasons. Fecal coliforms were not measured during this period, so there is not an equivalent quality baseline data set for this constituent. The University of California Davis (K. Tate, Department of Plant Sciences) has been simultaneously analyzing commensal *E. coli* and fecal coliform samples collected in Sierra Valley and other irrigated pasture systems in the central and northern Sierra Nevada mountain meadows. Figure 3 illustrates the high correlation found to exist between commensal *E. coli* and fecal coliforms in streams flowing through these systems, indicating that the same relative information is provided from commensal *E. coli* as compared to fecal coliforms. Based on the more robust ILRP data set for *E. coli,* the strong relationship with fecal coliforms, and the regulatory preference of *E. coli* as a pathogen indicator, fecal coliform bacteria will not be monitored for Core or Assessment monitoring.

Figure 3. Correlation between commensal *E. coli* and fecal coliforms for UFRW and other Sierra Nevada grazed, meadow stream systems in the central and northern Sierra Nevada during the 2007 irrigation season. Source: K.W. Tate, UC Davis.



Toxicity and Registered Pesticides

Water column and sediment/substrate toxicity assessments were conducted during the irrigation and wet season of 2006 and 2007. There was only one observed case of statistically significant toxicity at any of the 3 core and assessment monitoring locations during this period, and the toxicity was not persistent in the follow-up sample or the TIE conducted on the original sample. Aquatic macroinvertebrate sampling was also conducted at each the monitoring locations during the summers of 2006 and 2007, following protocols recommended by CDF&G/USEPA (Barbour et al., 1999). The results of the bioassessment confirmed that toxicity was not causing water quality impairments. Averaged results for the 3 monitoring locations were as follows: 1) richness of taxa was 20; 2) Shannon's diversity index was 2.1; and 3) the percent of the community composed of freshwater invertebrates sensitive to pollution (stoneflies, mayflies, and caddis flies; %EPT) was 50%. Although there is currently no quantitative standard for aquatic macroinvertebrate metrics, these values are considered to be relatively high values for pollution sensitive metrics and indicate that aquatic life beneficial uses are being well-supported in these streams. The toxicity and bioassessment results are inconsistent with toxicity-related water quality impairments to aquatic life beneficial uses in these waters.

The only agricultural application of MRP pesticides in 2006 was of glyphosate, and this included only 187 total acres of pasture and alfalfa. There were no applications of organophosphorus pesticides, carbamate pesticides, or other herbicides required for the MRP. Based on the lack of toxicity, negligible pesticide use, and high water quality indicated by bioassessment monitoring, continuation of toxicity and pesticide monitoring within the UFRW is not justified. If pesticide applications are determined to increase in the subwatershed, appropriate monitoring will be initiated during the next Assessment monitoring period.

Organochlorines

Organochlorines will be monitored in water samples during the first two monthly events of each Assessment monitoring period (May and June). Because these compounds have not been monitored previously in this subwatershed, they will also be monitored according to this schedule during the first Core monitoring period (2009). This schedule for monitoring organochlorine pesticides is based on the following.

- There were no agricultural applications of the only registered pesticide in this category (Dicofol).
- All other MRP organochlorines are legacy pesticides with no registered uses and there were no agricultural applications.
- Legacy organochlorine pesticides on the MRP parameter list are highly hydrophobic compounds that are bound to sediments. Consequently they are transported primarily through erosional processes associated with higher flows that typically occur with spring snowmelt runoff.

Metals and Metalloids

Trace metals will be monitored in water samples in May and June during Assessment monitoring. This schedule for monitoring metals is based on the following.

- There are no agricultural applications of any trace metals in this subwatershed.
- The majority of the metals on the MRP parameter list are transported primarily through erosive processes associated with high flows that typically occur with spring snow melt runoff in this subwatershed. Boron and selenium are more highly soluble trace elements whose transport in surface waters results primarily dissolution from soils with elevated concentrations.
- The other significant factor determining spatial distribution of elevated trace metal concentrations in surface waters is regional geology. The absence of exceedances of water quality objectives for MRP trace metals in prior Coalition monitoring in this subwatershed indicates that trace metals are not naturally elevated in this region. Based on the available data, monitoring of trace metals during the period of highest risk of erosional transport is sufficient to evaluate the risk of impacts from elevated metals concentrations.

Nutrients

Agricultural use of fertilizers is very limited with the UFRW. Fertilizer application is limited to alfalfa crops located primarily in the arid, eastern side of Sierra Valley. These systems are irrigated primarily with low-pressure wheel-line and center pivots, generating no irrigation runoff. Nutrients (nitrate, ammonium, total nitrogen, orthophosphate, and total phosphorus) were monitored at all 3 monitoring locations during the irrigation and wet season of 2005 through 2007. Table 6 summarizes nutrient results from 2006 and 2007. The low levels of nitrogen and phosphorus observed at these sites were well below water quality standards for human health.

The low concentrations also appear unlikely to stimulate excessive aquatic vegetation growth (personal communication, Dr. Ken Tate, UCD). During 2006-2007 monitoring, all surface water entering these valleys sampled, allowing calculation of the mass balance of nutrient load entering and exiting these agricultural areas. For all sample events over 2 years, there was a *net reduction* of instream nutrient loads in each valley. This is due to diversion of stream water entering the valleys and sequestration of nutrients in pasture/meadow vegetation and soil. The low nutrient concentrations observed below agricultural areas, the net loss of instream nutrients through agricultural areas, and the limited agricultural use of fertilizers within the UFRW do not support inclusion of nutrients within the Core monitoring program. Nutrients will be included in Assessment monitoring to track changes over time and to confirm that changes in agricultural practices and activities are not causing increases in ambient nutrient levels. During the 2008 irrigation season, specific nutrient analyses (nitrogen, phosphorus, and carbon) are also planned to be conducted on samples collected as part of a special monitoring project to understand factors driving dissolved oxygen and pH concentrations at the Sierra Valley and Indian Valley monitoring locations.

Table 9. MRP Parameters to be monitored at UFRW monitoring sites

Monitoring Parameters	Monitoring Type	Schedule
Photo Monitoring		
Photograph of monitoring location	Assessment and Core	MAY-SEP
WATER COLUMN SAMPLING		
Physical Parameters and General Chemistry		
Flow (field measure)	Assessment and Core	MAY-SEP
pH (field measure)	Assessment and Core + SP	MAY-SEP
Electrical Conductivity (field measure)	Assessment and Core	MAY-SEP
Dissolved Oxygen (field measure)	Assessment and Core + SP	MAY-SEP
Temperature (field measure)	Assessment and Core	MAY-SEP
Turbidity	Assessment and Core	MAY-SEP
Total Dissolved Solids	Assessment and Core	MAY-SEP
Total Suspended Solids	Assessment and Core	Est'd from turbidity
Hardness	Assessment and Core	MAY-JUN, with metals
Total Organic Carbon	Assessment and Core	MAY-SEP
Pathogens		
Fecal coliform	Special Project	None (Est'd from E. coli)
E. coli	Special Project	MAY-SEP
Water Column Toxicity Test		
Algae -*Selenastrum capricornutum*	Assessment	None, unless changes in pesticide use warrant reassessment
Water Flea - *Ceriodaphnia*	Assessment	
Fathead Minnow - *Pimephales*	Assessment	
Pesticides		
Carbamates		
Aldicarb	Assessment	None [Not Used]
Carbaryl	Assessment	None [Not Used]
Carbofuran	Assessment	None [Not Used]

Monitoring Parameters	Monitoring Type	Schedule
Methiocarb	Assessment	None [Not Used]
Methomyl	Assessment	None [Not Used]
Oxamyl	Assessment	None [Not Used]
Organochlorines		
DDD	Assessment (+ Core 2009)	MAY-JUN
DDE	Assessment (+ Core 2009)	MAY-JUN
DDT	Assessment (+ Core 2009)	MAY-JUN
Dicofol	Assessment (+ Core 2009)	None [Not Used]
Dieldrin	Assessment (+ Core 2009)	MAY-JUN
Endrin	Assessment (+ Core 2009)	MAY-JUN
Methoxychlor	Assessment (+ Core 2009)	MAY-JUN
Organophosphorus		
Azinphos-methyl	Assessment	None [Not Used]
Chlorpyrifos	Assessment	None [Not Used]
Diazinon	Assessment	None [Not Used]
Dichlorvos	Assessment	None [Not Used]
Dimethoate	Assessment	None [Not Used]
Demeton-s	Assessment	None [Not Used]
Disulfoton (Disyton)	Assessment	None [Not Used]
Malathion	Assessment	None [Not Used]
Methamidophos	Assessment	None [Not Used]
Methidathion	Assessment	None [Not Used]
Parathion-methyl	Assessment	None [Not Used]
Phorate	Assessment	None [Not Used]
Phosmet	Assessment	None [Not Used]
Herbicides		
Atrazine	Assessment	None [Not Used]
Cyanazine	Assessment	None [Not Used]
Diuron	Assessment	None [Not Used]
Glyphosate	Assessment	None [Insufficient Use]
Linuron	Assessment	None [Not Used]
Paraquat dichloride	Assessment	None [Not Used]
Simazine	Assessment	None [Not Used]
Trifluralin	Assessment	None [Not Used]
Metals		
Arsenic (total)	Assessment	MAY-JUN
Boron (total)	Assessment	None [No regional sources]
Cadmium (total and dissolved)	Assessment	MAY-JUN
Copper (total and dissolved)	Assessment	MAY-JUN
Lead (total and dissolved)	Assessment	MAY-JUN
Nickel (total and dissolved)	Assessment	MAY-JUN
Molybdenum (total)	Assessment	MAY-JUN
Selenium (total)	Assessment	None [No regional sources]
Zinc (total and dissolved)	Assessment	MAY-JUN

Monitoring Parameters	Monitoring Type	Schedule
Nutrients -		
Total Kjeldahl Nitrogen	Assessment Only	MAY-SEP
Nitrate plus Nitrite as Nitrogen	Assessment Only	MAY-SEP
Total Ammonia	Assessment Only	MAY-SEP
Unionized Ammonia (calculated value)	Assessment Only	MAY-SEP
Total Phosphorous (as P)	Assessment Only	MAY-SEP
Soluble Orthophosphate	Assessment Only	MAY-SEP
SEDIMENT SAMPLING		
Sediment Toxicity		
Hyalella azteca	Assessment	None, unless changes in pesticide use warrant reassessment
Pesticides		
Bifenthrin		
Cyfluthrin		
Cypermethrin		
Esfenvalerate		
Lambda-Cyhalothrin	Assessment	As needed for toxic sediments, based on criteria described in MRP Part II.E.2
Permethrin		
Fenpropathrin		
Chlorpyrifos		
Other sediment parameters		
TOC	Assessment	with sediment toxicity sampling

18. QAPP

All monitoring conducted for MRPP will be conducted in accordance with the approved Quality Assurance Project Plan (QAPP) **(Appendix E)**.

19. DOCUMENTATION OF MONITORING PROTOCOLS

All monitoring protocols required for the MRPP are documented in the QAPP **(Appendix E)**.

20. COALITION GROUP CONTACT INFORMATION

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Appendix A. Subwatershed and Drainage Maps

Appendix B. Calendar of Agricultural Activities

Appendix C. Pesticide Use Information

Appendix D. Summaries of Management Practices by County

Summaries from PRMS Reports

Appendix E. Quality Assurance Project Plan